

Department for Transport

National Travel Survey Digital Diary

Alpha Report



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Version: 6.0 (FINAL)

Executive Summary

We conducted a 15-week Alpha phase, looking into the development of a digital version of the Department for Transport's National Travel Survey paper diary, as per the recommendations in the Discovery report written by Lagom Strategy in January 2019.

During that time, we focused on learning the risks and potential solutions for:

1. A digital version of the National Travel Survey paper diary
2. An enhanced version of the digital diary
3. A prototype native phone app for tracking participant journeys via GPS

This included investigating the structure of the survey data, the security policies around storing and interrogating diary data, and identifying the current burden on participants and interviewers to achieve survey completion.

We also explored the potential use of and barriers to the development of a native GPS-tracking app within the Government Digital Service (GDS) framework.

Recommendations

At the end of Alpha, our recommendations are:

1. Progress to Beta to develop additional enhancements to the Digital Diary with the aim of further reducing interviewer burden, and improving participant experience and data quality, including:
 - Sharing journeys
 - Household diary access
 - GPS functionality
 - User-centered mapping
 - Automatic distance validation
 - Automatic time population
 - Participant - interviewer help system
2. Once the MVP of the web-based digital diary is built, begin a separate Alpha to further investigate and develop a prototype native phone app for use with or instead of the paper and digital diaries.

[Recommended KPIs for Beta](#) can be found on page 81.

A development backlog for Beta can be found in [Appendix 2](#).

Contents

Executive Summary	2
Recommendations	2
Contents	3
Introduction	5
Background	5
Pre-discovery	5
Discovery	6
Alpha objectives	8
MVP Digital Diary	8
Enhanced Digital Diary	9
Browser-based Geolocation	9
Native GPS App	9
User Research	10
Who are the users?	10
Key user needs	10
User Experience recommendations from Discovery:	11
What we did	11
Iterations	12
NTS Interviewer Research	13
New Survey Respondent Research	15
Previous Survey Respondent Research	21
NTS Coder Research	23
DfT NTS User Research	25
User Research Methodology	27
Interviews	27
User Testing	27
GPS Journey Tracker Companion App	28
Native GPS App Visual Prototype	28
Sprints	29
Prototypes	33
Data Schema	33
API	34
MVP Digital Diary prototype	35
Enhanced Digital Diary prototype	37
GPS Journey Tracker Companion App prototype	39
Native GPS App visual prototype	41
Native GPS App Research	43

Companion App Development (app level 1)	45
Apps Level 2 & 3 Research and Design	46
Proposed architecture for Apps level 2 & 3	47
Design research for full app (levels 2 & 3)	48
Changing attitudes towards Native Apps	50
Response and recommendations	52
Alpha Findings Review	55
Enhanced Digital Diary Testing Outcomes	59
NTS Interviewers (NatCen)	59
Survey Respondents (Diary Keepers)	61
NTS Coders (NatCen)	64
Accessibility	70
Conclusions	72
Browser-based Geolocation	73
Conclusions	73
NTS Smartphone App	74
GPS Journey Tracker Companion App (level 1 app)	75
GPS Native NTS App	76
Conclusions	78
Beta Recommendations for the National Travel Survey Digital Diary	80
Support in Beta	80
KPIs for Beta	81
Appendices	83
Appendix 1: Validation Error Log Summary	83
Appendix 2: Backlog	85
Appendix 3: All User Journeys	87
Appendix 4: All User Personas	91
Appendix 5: Previous NTS Studies	94
Appendix 6: National Travel Survey trials and reports from other countries	95
Appendix 7: GDS Assessment	96

Introduction

The main component of the National Travel Survey (NTS) is a one-week travel diary completed by 15,000 participants each year using pen and paper. A Discovery phase carried out in 2018-19 concluded that a well-designed digital diary would better meet user needs than a paper diary as it could collect better quality data and reduce respondent burden.

The Discovery report advised to test two prototypes in Alpha - a web-based form replicating the paper diary as a Minimum Viable Product (MVP) and an enhanced diary with additional features such as return journeys and repeat journeys, and offline mode - and then use the digital prototypes to identify solutions to develop in Beta.

Background

The National Travel Survey (NTS) is a continuous household survey designed to monitor long-term trends in personal travel and to inform the development of policy. It began in the mid-1960s and is the primary source of data on personal travel patterns by residents of England.

The survey collects information on how, why, when and where people travel and covers people in all age groups, including children.

NTS data is collected via two main methods:

1. Interviews - face-to-face interviews are carried out with all members of the household to collect personal and household information, including the vehicles to which they have access.
2. 7 day Travel Diary - each householder separately records details of all journeys over a week.

In 2018 6,045 households participated fully in the survey (i.e. provided info via interview and completed the seven day Travel Diary). An additional 666 households participated in the interviews but did not complete a diary.

Pre-discovery

Due to a decline in response rates in recent years and consistent issues surrounding data quality and survey completion, the NTS team have been looking for ways to improve the survey, with a view to using technology to achieve this. There have been several investigative projects looking into that possibility.

In 2011, GPS devices were issued to NTS participants as a trial to explore the potential of using GPS to capture journeys. GPS was not adopted after the trial finished,

“on the basis of the numerous and substantial differences between the results

The tested GPS technology was unable to capture several key data points, including mode of transport and journey purpose. There were also concerns about the absence of children in the data.

In 2016, an in-depth review of available technology was conducted, specifically looking at a web-based digital survey, GPS devices (e.g. smartphones) and new data sources (e.g. mobile network data). It was recommended that a web-based diary could replace the paper diary in the short to medium term.¹

The report also recommended that a mobile app version could be developed to replace the paper diaries within 5 years, when the bias in the age profile of smartphone users has been sufficiently removed.²

Discovery

A four month Discovery phase³ was conducted in 2018/19 focussing on:

- NTS participant experience, behaviour and needs
- How a digital diary could support the goals of the DfT, the participants and survey managers
- Understanding the risks and barriers of moving to digitised experience, particularly in relation to those with assisted digital needs
- The internal and external technological opportunities and constraints

The key points influencing the Discovery recommendations are:

1. To preserve the NTS question bank and method
This has been stable for a long time and is regularly cited as a strength by data users.
2. The desire to increase the sample size
The Discovery phase established that a digitised version of the diary would not increase sample size significantly on its own, whereas developing multiple digital methods would.

A key takeaway from Discovery was that,

¹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641452/modernising-the-national-travel-survey.pdf - page 60

² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641452/modernising-the-national-travel-survey.pdf - page 1

³ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/804635/nts-digital-diary-discovery-report.pdf

“Unfortunately, digital technology is not a silver bullet”

The Discovery report learnt from the experience of the New Zealand travel survey, which transitioned from a paper collection method to a digital collection method that also made use of GPS tracking. Despite the use of GPS tracking, they still had to rely on significant facilitation by Interviewers to complete the data. Likewise, the original GPS pilot for the NTS found that it could not capture all the data required by the survey and that there were numerous differences between the data collected via GPS and that collected via the paper diary.

The main, overarching recommendations from the Discovery phase were:

1. To develop a Minimum Viable Product (MVP) Digital Travel Diary
2. Road map the vision of an Enhanced Digital Travel Diary in the form of a progressive web app (not native phone app)
3. Use the Alpha as a genuine learning experience (rather than a first phase of development)
4. Build towards a second digital-only NTS service / tier which can yield a much larger sample size

Alpha objectives

This Alpha focused on designing a digital diary to collect quality data, reduce respondent/interviewer burden and increase efficiencies, while developing prototypes for:

- A digital version of the paper diary
- An enhanced version of the digital diary
- A native, GPS-tracking mobile phone app

Other Alpha objectives were to:

- Develop and test both the MVP and enhanced prototypes, identifying problems and finding solutions, demonstrating technical, financial, contractual and legal feasibility
- Test features and research questions identified in the Discovery report
- Provide indicative breakdown of system development and post-build lifetime costs (including hosting) for the MVP and enhanced diaries separately
- Establish how to create an efficient structure for processing diary data
- Identify what is required in Beta, highlighting risks/dependencies

Key questions asked regularly throughout the Alpha phase, during both prototype development and user research:

1. Can Diary Keepers complete the prototype digital diaries without onboarding or intervention from an Interviewer?
2. How much will this version reduce the burden on multi-Diary Keepers?
3. How much will it reduce the burden on Interviewers?
4. Are we getting more data and is the data collected more accurate than the paper diary?
5. Does it reduce the levels of manual intervention to validate the data?
6. Can a physical 'pick up' be removed from the process?
7. How much can the manual journey purpose coding be removed from the process?
8. What is the preference (or not) of users towards a digital diary?
9. What will the impact be on sample size and composition?

MVP Digital Diary

The Digital Diary is the online version of the paper diary in its most basic form. It has minimal enhancements and aims primarily to replicate the fields and requirements of the paper diary.

It includes the development of an Interviewer Dashboard, allowing them to set up a household, add household members and vehicles, and view the household's diaries as the week progresses.

It was also recommended that the MVP include some additional features, such as return/repeat journey copying, to reduce Diary Keeper and coding burden wherever possible, and that it should be fully accessible.

Enhanced Digital Diary

The Enhanced Digital Diary is an iterative prototype focussing on improving data quality, reducing interviewer burden and making it easier for participants, including those with assisted digital needs.

Enhancements include prompt messages and alerts for participants, offline usage and email notifications for interviewers regarding diary progress.

It also includes error logging so that we can learn where users are struggling and identify common pain points in the online process for NTS participants.

At the beginning of the project, we decided that the enhanced features should be built within the Basic/MVP (with the ability to disable/enable each feature with a config switch), rather than as a separate Progressive Web App. We made this decision to ensure that the application stayed within GDS guidelines of working without Javascript, to reduce development time/code duplication, and to reduce technical debt within the project.

Browser-based Geolocation

In order to establish whether geolocation services within a web browser could be used for either a smartphone-based web version of the NTS or a pin-to-pin journey mapping feature within the Digital Diary, we needed to explore and establish accuracy of such services.

Native GPS App

Due to GDS guidelines and concerns around data collection and participant privacy, we limited the native app prototype to a simple 'Stop/Start' journey tracker as proof of concept that was tested within the project team. This enabled us to test the quality of the data collected, the effect of such an app on phone battery life, and the development road map for both iOS and Android app stores.

We did several rounds of research and design to explore possible use of a native app for the NTS. We also submitted Data Protection Impact Assessments and High Level Designs relating to proposed app phases to test acceptance within the DfT's digital framework and guidelines.

User Research

At the beginning of the project, we recruited 19 user testers for user research and testing, who had never heard of the NTS before. These people were aged between 15-70 years old, from locations throughout the UK. A number had additional needs, such as dyslexia, mobility issues and low digital confidence.

With the help of the DfT and survey conductors NatCen, we also recruited a further 6 users who had previously completed the NTS Interview and been given paper diaries. 5 of those users had completed their paper travel diaries and 1 had dropped out part way through. NatCen provided us with contacts for 6 Interviewers who had been conducting the survey interviews and collecting the paper diaries for some years. We also spent a day with a Coder at the NatCen offices in Brentwood to better understand how the data is coded and inputted for interrogation.

Important Note: Due to the coronavirus pandemic, we were unable to conduct in-person interviews or moderated testing after 16th March 2020, with a number of testers declining to meet in the fortnight prior to that. We had planned to use the DVLA testing lab in Swansea for final moderated workshop testing but instead have had to adapt to video conferencing and screen-sharing where possible to conduct moderated testing. This posed an additional challenge for testing with those who were less digitally confident or for those with additional needs, although it didn't affect the testing outcomes with those users.

Who are the users?

User groups identified:

- NTS Interviewer
- NTS Survey Respondent (Diary Keeper)
- NTS Coder
- DfT/NTS Analyst

Key user needs

The key user needs identified are:

- Reduce input/correction burden on NTS Interviewers
- Reduce input burden on NTS Survey respondents
- Improve data quality for DfT and coders
- Reduce drop-off in survey completion (Diary Keepers tend to complete the diary but write less in the diary as the week progresses)

User Experience recommendations from Discovery:

1. Offer NTS participants a mixed-mode digital Travel Diary experience
2. Do the hard work for users/reduce cognitive load
3. Enable the Interviewers
4. Enable the multi-Diary Keepers
5. Tailor the Diary to the Diary Keeper's context
6. Nudge Diary Keepers
7. Embrace the accessibility potential of digital
8. Aim to build a digital diary that does not require concierge service from the Interviewers
9. Remove the need for a physical pick up call

What we did

The following users were engaged for user testing and feedback:

- 19 people were engaged remotely as New Survey Respondents for online user testing
 - 1-2 testing sessions each, inputting dummy data into the Digital Diary
 - 17 interviews were conducted, 6 in person, 11 via email/phone
- 6 people were engaged remotely as Previous Survey Respondents for online user testing
 - 1 testing session each, inputting dummy data into the Digital Diary
 - 6 interviews were conducted via email
- 6 NatCen interviewers were directly engaged
 - 6 interviews were conducted pre-testing to identify common issues
 - Individual online testing sessions, inputting dummy household data using the Interviewers Dashboard
 - 3 interviews were conducted post-testing for feedback
 - 1 Interviewer reviewed and sense-checked the inputted data to gauge both ease of moderation and quality of data
- 1 NatCen coder was directly engaged
 - A workshop was held to meet and interview a current NTS coder to identify common issues with the existing paper diary and the data received
 - Coder checked 'week view' of testing data at conclusion to check the data quality and whether it could be successfully coded
- 1 DfT analyst was acting as product owner for the project and was directly engaged throughout

Other activities:

- Iterate designs based on feedback from user interviews and user testing
- Embedded tracking in GPS app prototype (project members only)
- Research and Demo design for full native app

Iterations

Over the course of the project there were 10 iterations of the two Digital Diary prototypes, and 1 iteration of the App prototype. The following hypotheses were tested and iterated on:

NTS Interviewers

- Digital Diary (basic): Add household
- Digital Diary (basic): Add household member
- Digital Diary (basic): Set notification preferences
- Digital Diary (basic): Set preferred mode of transport
- Digital Diary (basic): Add vehicle/s to household
- Digital Diary (basic): Set preferred ticket types
- Digital Diary (basic): Review diary
- Digital Diary (basic): Edit journeys entered
- Digital Diary (basic): Add missing journeys
- Digital Diary (enhanced): Generate prompt to add journeys
- Digital Diary (enhanced): Create return journeys

NTS Survey Respondents

- Digital Diary (basic): Access diary
- Digital Diary (basic): Add journey
- Digital Diary (basic): Edit journey
- Digital Diary (basic): Submit diary
- Digital Diary (enhanced): Make a return journey
- Digital Diary (enhanced): Repeat/duplicate journey
- Digital Diary (enhanced): Set up and label favourite locations

NTS Coders

- Digital Diary (basic): Review journey data
- Digital Diary (basic): Edit journey data

NTS Interviewer Research

We created 1 user persona and 1 user journey for NTS Interviewers.

Interviewer Persona: Geoff Hanneman

Age: 43

Contracted working for NatCen on several different surveys. Working for NatCen for 15 years, working on the NTS for 8 years. Digitally fairly confident, though wouldn't call himself technical.

Digital Inclusion Scale: 7 - Basic Digital Skills

Methodologies

- Phone interviews
- Moderated testing via phone

Number of users interviewed

- 6 NatCen interviewers

Goals

- To access the Interviewer Dashboard
- To set up a household of respondents
- To view and edit a respondent's journey data in real time
- To digitally prompt respondents to add journeys

Needs

As a National Travel Survey interviewer, I need to be able to access the interviewer dashboard to set up a household.

As an NTS interviewer, I need to be able to view and edit a respondent's journey data, and assist them with entering the correct data.

As an NTS interviewer, I need to be able to monitor progress of a household's diary and send digital notifications to prompt respondents to add journeys.

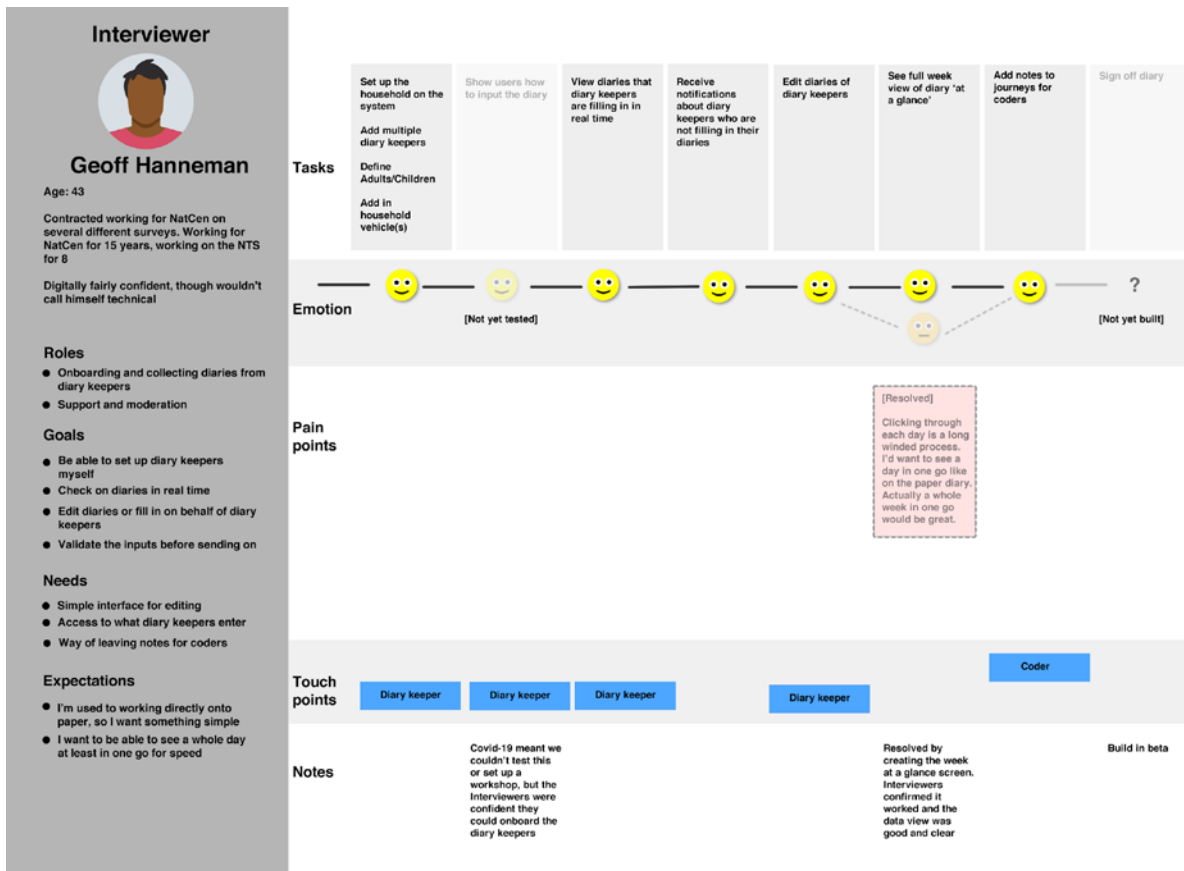
As someone who is used to the paper diary, it needs to be simple to use and easy for me to understand.

Barriers

- Over-complex interface
- Not being able to see much information at a glance
- Not being able to pick it up quickly



User Persona & Journey Image:



New Survey Respondent Research

We created 10 user personas and 4 user journeys for New NTS Diary Keepers.

We selected 4 users to create user journeys for, in order to encompass a wider variety of expectations and barriers and to reflect our testing group.

See [Appendix 3: All User Journeys](#) and [Appendix 4: All User Personas](#) for more.

New Survey Respondent Persona 1: Alison Peters

Age: 41

Professional business consultant who works for herself. Educated to Masters level. No children, varied social life. Lives in an urban area, has a motorbike but also uses public transport and private cars when needed. Diary keeper for household.

Digital Inclusion Scale: 9 - Expert

Methodologies

- Phone and email interviews
- Unmoderated testing of prototype (remote/online)

Number of users

- 4 remote users

Goals

- To get set up quickly
- To be able to log in and fill in on the move
- To complete a Diary and submit it

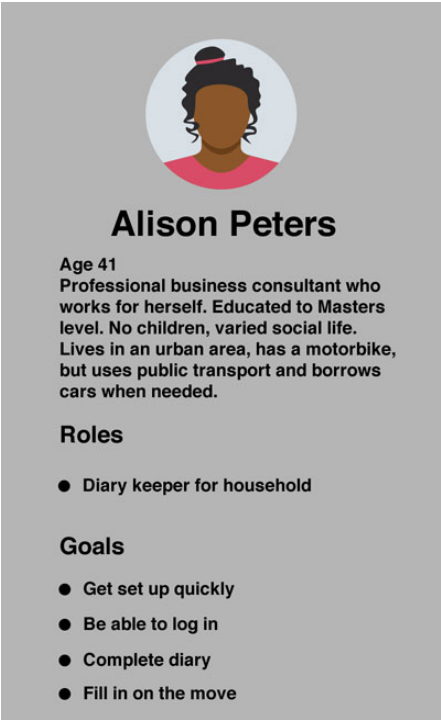
Needs

As a National Travel Survey respondent, I need a logical system that works quickly and is easy to access.

As an NTS respondent, I need to understand how my data will be used and will help to inform governance.

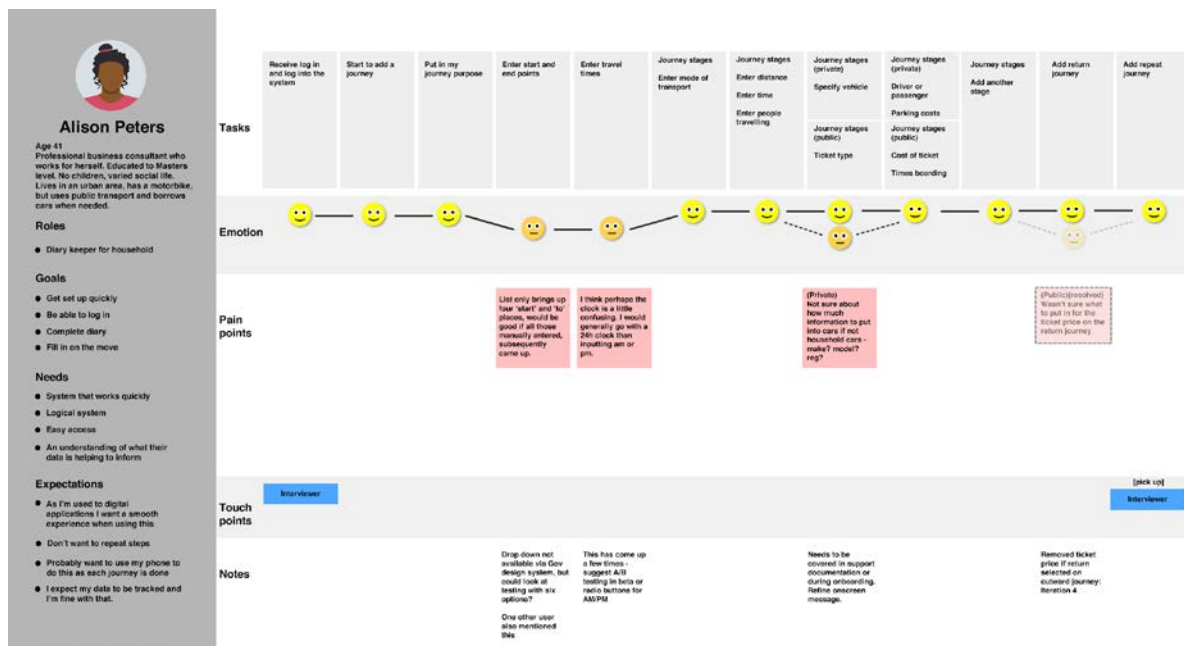
Barriers

- Not being properly responsive for mobile devices
- Being slow to load
- Having to repeat too many steps



The image shows a grey rectangular card representing a user persona. At the top is a circular profile picture of a woman with dark hair in a bun, wearing a red top. Below the picture is the name 'Alison Peters' in bold black text. Underneath the name is a block of text: 'Age 41 Professional business consultant who works for herself. Educated to Masters level. No children, varied social life. Lives in an urban area, has a motorbike, but uses public transport and borrows cars when needed.' Below this text are three sections: 'Roles' with one bullet point 'Diary keeper for household', 'Goals' with three bullet points 'Get set up quickly', 'Be able to log in', and 'Complete diary', and 'Fill in on the move'.

User Persona & Journey Image:



New Survey Respondent Persona 2: Sam Eversfield

Age: 43

Dyslexic. Lives with partner and two children in a village. Uses car extensively for travelling for work, dropping kids at various events, shopping and to ferry around her elderly mother. Digitally fairly confident, happy using phones, social media and apps. Has a smartphone and a PC laptop for work but is primarily a phone user. Diary keeper for household.

Digital Inclusion Scale: 7 - Basic Digital Skills

Methodologies

- Phone and email interviews
- Unmoderated testing of prototype (remote/online)

Number of users interviewed

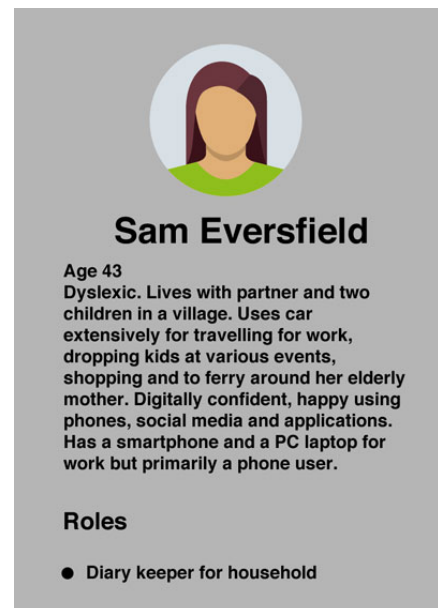
- 1 user

Goals

- To get set up quickly
- To be able to log in and fill in on mobile devices as I go along
- To complete a Diary and submit it

Needs

As someone with dyslexia, I need clear language and logical form flow. Not too many steps. As someone with dyslexia, I need to be able to edit my journey data in case I make mistakes.



New Survey Respondent Persona 4: Anthony Walsh

Age: 68

Lives with partner. Children grown up and left home. Runs village post office. Lives in a rural village. Doesn't use public transport. Not very active. Drives everywhere.

Digitally very confident and happy using mobile phones, social media and apps. Has a smartphone, an iPad and a PC laptop. Prefers larger devices.

Digital Inclusion Scale: 8 - Confident

Methodologies

- Phone and email interviews
- Unmoderated testing of prototype (remote/online)

Number of users

- 2 remote users

Goals

- To fill in the diary easily, preferably using data collected via phone
- To do as little as possible, as quickly as possible
- To have some parts done for me by automatic means
- To complete a Diary and submit it

Needs

As a National Travel Survey respondent, I need to be able to access the diary easily and fill it in as quickly as possible.

As someone living in a rural location with regular travel habits, I want the Digital Diary form to be as abbreviated as possible.

As someone unused to doing detailed admin, I don't want to have to spend time looking up information to fill in the diary, particularly if it can be gathered in another way.

As a busy person, I want to just record everything and let the NTS strip out what it doesn't want.

Barriers

- Having to repeat steps or duplicate information
- Taking too long to input a journey
- Having to do too much working out to fill in the required information
- Likely to quit if it's not easy enough



Anthony Walsh

Age 68


Lives with partner, Children grown and left. Runs village post office. Lives in a rural village. Doesn't use public transport. Not very active. Drives everywhere.

Digitally very confident, happy using phones, social media and applications. Has a smartphone, an iPad and a PC laptop. Prefers larger devices

Roles

- Diary keeper
- Likely to defer to partner keeping diary for him if an option

User Persona & Journey Image:



Anthony Walsh
Age 48
Lives with partner. Children grown and left. Runs village post office. Lives in a rural village. Doesn't use public transport. Not very active. Drives everywhere.
Digitally very confident, happy using phones, social media and applications. Has a smartphone, an iPad and a PC laptop. Prefers larger devices

Roles

- Diary keeper
- Likely to defer to partner keeping diary for him if an option

Goals


- Fill in diary easily, preferably using data collected on phone
- Do as little as possible, as quickly as possible
- Complete diary

Needs

- Auto-filling wherever I think it should be possible
- As streamlined as possible
- Logical form flow
- Easy access

Expectations

- I don't expect this to take very long
- Don't want to repeat steps
- Probably want to use my phone to do this every evening after the fact
- Expect phone to collect data for me and auto-fill most fields

Receive log in and log into the system	Start to add a journey	Put in my journey purpose	Enter start and end points	Enter travel times	Journey stages Enter mode of transport	Journey stages Enter distance Enter time Enter people travelling	Journey stages (private) Specify vehicle	Journey stages (private) Driver or passenger Parking costs	Journey stages (public) Add another stage	Add return journey	Add repeat journey
											
<p>Pain points</p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid #ccc; padding: 5px; width: 20%;"> Why can't I just put in the postcode? </div> <div style="border: 1px solid #ccc; padding: 5px; width: 20%;"> I would have thought this would be better as date/clock </div> <div style="border: 1px solid #ccc; padding: 5px; width: 20%;"> Feels a bit annoying having to put stages for just driving a car to one place </div> <div style="border: 1px solid #ccc; padding: 5px; width: 20%;"> I've already put in how long my journey took, why is it asking me for this again? Can't it automatically fill this in for me by calculating from my journey time? </div> <div style="border: 1px solid #ccc; padding: 5px; width: 20%;"> I've already said that I was the only person travelling, so if I'm in a car it stands to reason that I must be the driver. It should have worked this out based on my earlier answer about how many people were travelling. </div> </div>											
<p>Touch points</p> <div style="display: flex; justify-content: space-between;"> Interviewer Interviewee </div>											
<p>Notes</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 20%;"> Could look into this as an enhancement, but the level of prioritising would have to be carefully managed and checked with the Data Assurance team </div> <div style="width: 20%;"> This has come up a few times - suggest A/B testing in beta or metrics feature for A/B/M </div> <div style="width: 20%;"> At the point of putting in the first stage the wizard doesn't know if a car driver is going door to door, or parking at a station then taking the train </div> <div style="width: 20%;"> This would only work with door-to-door journeys as the NTS Smart record time walking (at a bus stop, or walking for train, for example) as part of the journey time </div> <div style="width: 20%;"> This should be looked at for development into beta. We already do some validation here, for example a child cannot be the driver so the option isn't offered </div> </div>											

Previous Survey Respondent Research

We created 1 user persona for a previous NTS Diary Keeper. As most NTS surveyed households are new respondents, this was generated based on our research with the NTS Interviewers and previous NTS respondents.

Previous Diary Keeper Persona: Belinda Guthrie

Age: 28

Married. Lives with partner and three children in a city. Uses a mixture of public and private transport. Digitally very confident. Happy using phone apps. Will be completing diaries on behalf of her children and possibly her partner too.

Digital Inclusion Scale: 8 - Confident

Methodologies

- Email interviews
- Unmoderated testing (remote)

Number of users interviewed

- 6 users

Goals

- To input a series of dummy journey data into the Digital Diary
- To fill in the diary across multiple devices as I go along
- To complete a Diary and submit it

Needs

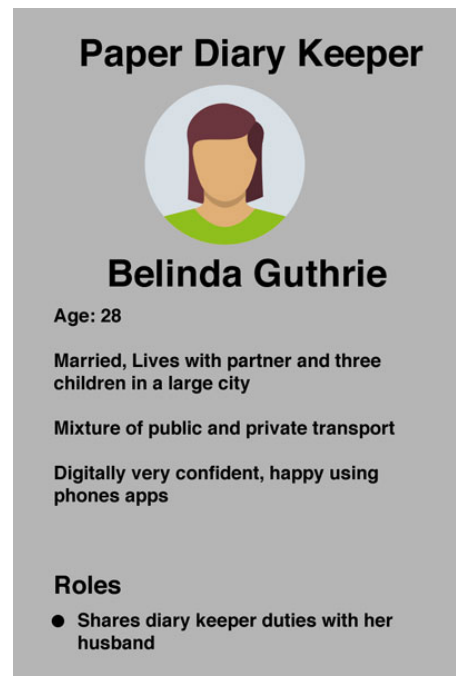
As a previous NTS respondent, I need to be able to input different types of journey data to the same web form with the same ease or more easily than the paper diary.

As a parent of three children, I need to be able to enter journeys for my family as well as for myself.

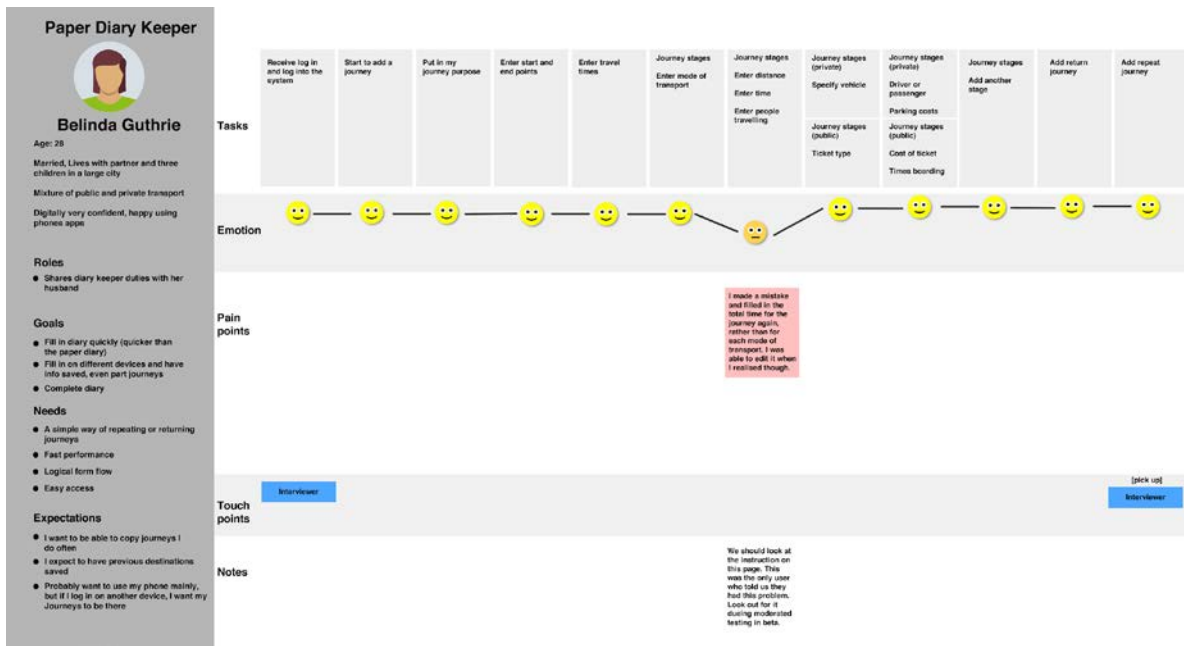
As someone who lives in the city, I need to be able to input multi-stage and multi-mode journeys without too much complexity.

Barriers

- If the web form was more complex than the paper diary
- If I couldn't speed up my data input
- If I couldn't enter journeys on behalf of my children
- If multi-stage journeys were too difficult to input



User Persona & Journey Image:



NTS Coder Research

We created 1 user persona and 1 user journey for NTS Coders.

NTS Coder Persona: Valerie Pickwick

Age: 41

Lives near Brentwood, works in the NatCen office. Knows the codes by heart, finds it difficult to conceptualize how a digital diary might work. Can code ten households per hour.

Digital Inclusion Scale: 7 - Basic Digital Skills

Methodologies

- Phone and email interviews
- In person workshop

Number of users interviewed

- 1 NatCen data coders

Goals

- To access the Digital Diary data after completion
- To interrogate that data
- To import that data into our data system
- To speed up the coding process

Needs

As a National Travel Survey data coder, I need to be able to import the data from the Digital Diaries into my company's data system, to sit alongside data that has been gathered offline from the paper diaries.

As an NTS coder, I need to be able to interrogate that data alongside the paper diary data.

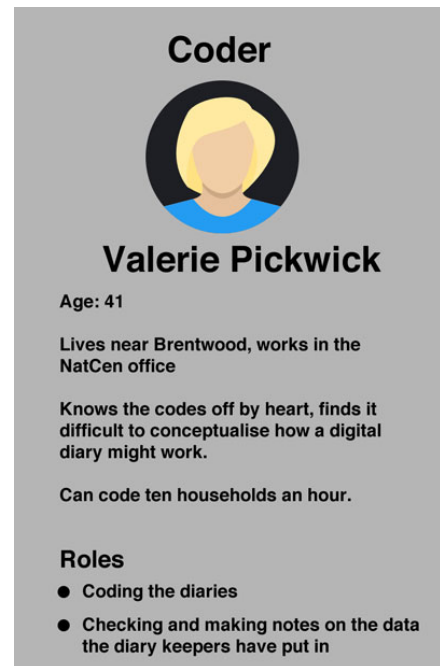
As an NTS coder, I need to have access to a Notes field from the Interviewer for important data verification purposes and to explain any anomalies.

Barriers

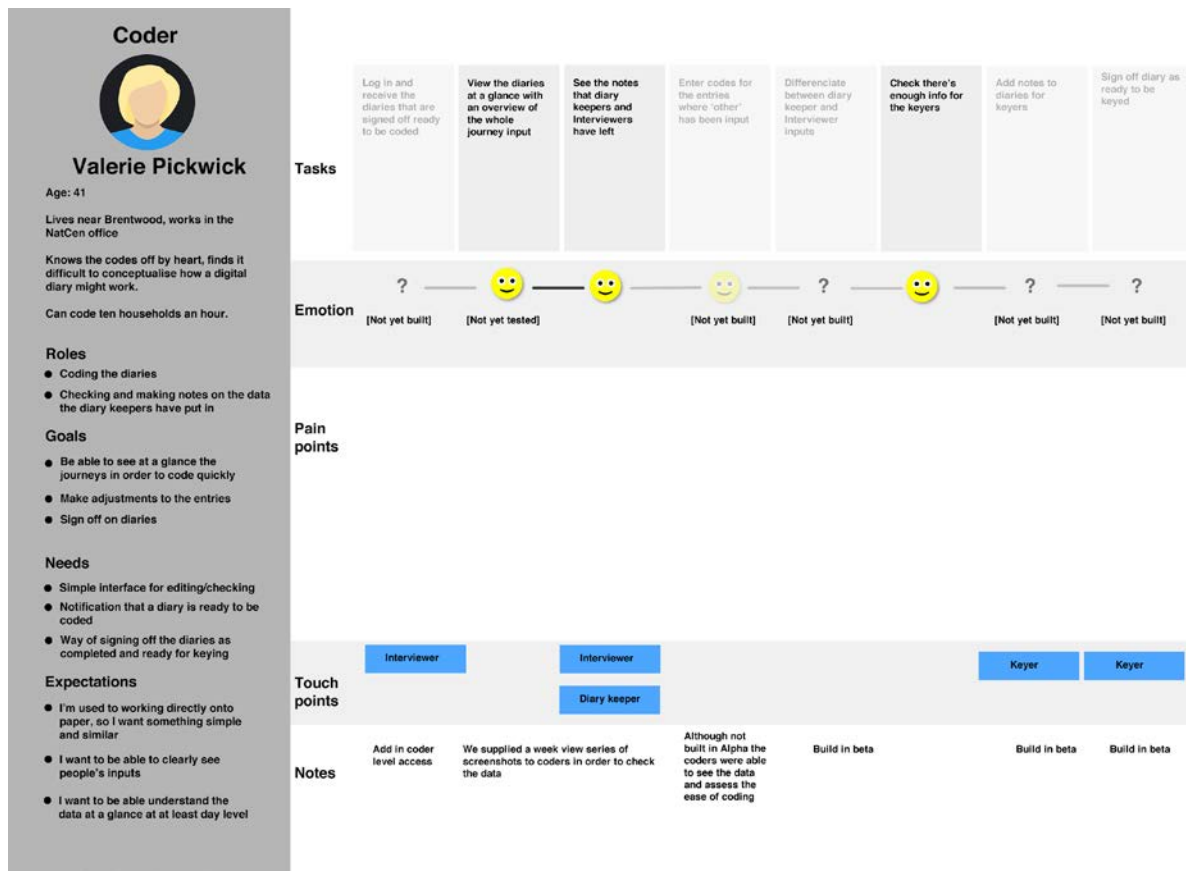
- Too difficult to access the completed diary data
- Not receiving the data in the correct format
- Makes the coding process slower or more difficult

Recommendations for Beta research

- Build and test a coder dashboard with input fields for coders to add or select codes
- Test a wider range of user journey data (especially from actual journeys) with coders to confirm data quality is high and the codes can be assigned
- Workshop/demonstrate the prototype early on to coders as their collaboration will be needed and they will be able to spot potential data inconsistencies
- Involve the coders in the discussion about cross-referencing diaries within households



User Persona & Journey Image:



DfT NTS User Research

We created 1 user persona for the internal DfT NTS user.

DfT NTS Analyst User Persona: Erik Ulverson

Age: 34

Lives with partner. No children. Lives in London, works in the centre and commutes in. Commutes by bus and underground. Digitally confident, expert in data interpretation. Happy using phones and applications. Has a smartphone and a PC.

Digital Inclusion Scale: 9 - Expert

Note: This persona was represented throughout the project by the DfT NTS product owner.

Methodologies

- In person interviews
- Email & phone interviews
- Contribution throughout the project

Number of users interviewed

- 1 DfT member

Goals

- To access the data from the Digital Diaries
- To be able to interrogate data from the NTS
- To increase the NTS sample size
- To improve diary completion rates and data quality
- To be able to collect and access data at local authority level

Needs

As a Department for Transport employee, I need to be able to access the data gathered from the Digital Diaries in its raw form and interrogate it.

As a representative of the DfT, we would like to increase sample size for the NTS, scaling the survey up to gather data at a more local level.

We would like to increase diary completion rates and increase representation within certain demographics.

As a representative of the DfT, we would like to improve the quality of the data gathered by the NTS.


As a DfT statistician, I'd like to be able to increase the local data gathered by the NTS.



Barriers

- Not being able to scale up the National Travel Survey
- Not being able to access the data in its raw form

User Persona & Journey Image:

<p>DfT/NTS Analyst</p>  <p>Erik Ulverson</p> <p>Age: 34</p> <p>Lives with partner. No children.</p> <p>Lives in London, works in the centre and commutes in.</p> <p>Commutes by bus and underground.</p> <p>Digitally confident, expert in data interpretation. Happy using phones and applications. Has a smartphone and a PC.</p> <p>Roles</p> <ul style="list-style-type: none">● Data analysis● Support for Transport professionals. Transport researchers, Policy researchers and data novices	<p>Goals</p> <ul style="list-style-type: none">● Increase take up of diary● Preserve dataset and integrity● Expand sample size <p>Needs</p> <ul style="list-style-type: none">● Highest quality of data possible● A scalable solution● To know more about shorter trips● More granular data <p>Expectations</p> <ul style="list-style-type: none">● Faster turnaround between diary being filled in and data arriving● Higher take up	<p>Pain points</p> <ul style="list-style-type: none">● Estimated journey differences● The knowledge that many short journeys are lost● Sample size being too small for detailed analysis at local level● Trying to satisfy all the requests that come to the DfT <p>Notes</p> <p>Tasks include:</p> <p>Receive cleaned data from NatCen</p> <p>Oversee NTS coordination</p> <p>Use NTS data to answer queries</p>
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User Research Methodology

Methods used to gather feedback from the key user types were:

Interviews

We interviewed 25 Survey Respondents, 6 NTS Interviewers and 1 NTS Coder. The team Product Owner, as a DfT Statistician, represented the NTS/DfT user persona. The aims were:

NTS Interviewers

- To identify potential ways of reducing the intervention burden
- To gain feedback on Digital Diary version (vs paper version)
- To identify any further improvements that could be made

New Survey Respondents (Diary Keepers)

- To identify the usability of the Digital Diary
- To ask whether they would prefer to use a smartphone app or an online page to record data

Previous Survey Respondents (Diary Keepers)

- To identify the usability of the Digital Diary
- To ask whether they would prefer to use a smartphone app, an online page to record data, or the paper diary they used to complete the NTS
- To identify any ways of making the survey easier to fill in
- To identify reasons for response drop-off within households

NTS Coders

- To investigate data route and architecture for existing paper diaries
- To identify common problems/issues with data received from paper diary
- To gain feedback on quality of data received via Digital Diary API

DfT NTS Users

- To establish long-term goals for the quality of data collected
- To identify common issues with the response rate for the NTS

User Testing

Due to the coronavirus pandemic, we were unable to run a moderated testing workshop as originally planned. Instead, we set up 4 testing groups for 4 waves of testing, each one with a different diary version, then re-tested new iterations with previous users to gauge improvement. Adding new testers in each wave ensured we had people testing it without prior knowledge of the diary's workings, as well as re-testers from the previous group whose feedback had driven the new iteration.

We invited 25 Survey Respondents for testing, 19 new and 6 who had previously filled in the paper diary, to validate the needs identified during the Discovery phase and to test two versions of the Digital Diary - the basic version and enhanced version. The testing aims were:

- To test ease-of-use of the basic Digital Diary
- To understand whether the Digital Diary is more or less convenient than the paper diary, easier or harder to fill in
- To test the enhanced Digital Diary, and gather feedback on version preference

Moderated Testing

We were able to carry out in-person moderation testing with 2 households (4 individuals) prior to March 2020, when social distancing restrictions were put in place. However, we were able to conduct moderated testing via phone and screen share with a further 5 individuals, and unmoderated testing with 10 individuals.

Remote Online Testing

We asked 19 new Survey Respondents to test the two online versions of the Digital Diary remotely. The testing aims were:

- To test ease-of-use of the basic Digital Diary
- To test the enhanced Digital Diary, and gather feedback on version preference

We also asked 6 previous Survey Respondents to test the final iteration of the Digital Diary. The testing aims were:

- To gauge ease-of-use when compared to the paper diary
- To compare data quality and completion rates
- To establish preferences for format

GPS Journey Tracker Companion App

Due to concerns over GDS and data collection with real users, we asked 3 members of the project team to download a GPS app to record journeys. The testing aims were:

- To test accuracy and usefulness of GPS-tracked data
- To test performance of devices with GPS-tracking enabled
- To identify number and points of necessary respondent intervention to generate journey data, as per the National Travel Survey requirements

Native GPS App Visual Prototype

We designed and built a flat visual prototype of a full app-version of the National Travel Survey:

- To investigate design solutions and a user flow for capturing journeys
- To show users how an app might work to capture their journeys automatically, in order to facilitate their feedback on whether or not they'd use an app

Sprints

This Alpha phase was originally a 12 week, 6 sprint project but was extended a further 3 weeks to include the development of a third prototype, resulting in a 15 week, 8 sprint project.

Sprint 0

- Kick off meeting
- Stakeholder and user research
- Data Plan scheme and Change Board approval
- Recruitment of user testers

Sprint 1

- Stakeholder and user research
- Development of API
- Meeting with NatCen
- Continued recruitment of user testers

Sprint 2

- Development of web-based MVP Digital Diary
- Digital Diary, iteration 1 deployed, including:
 - Interviewer dashboard (view households/DKs)
 - DiaryKeeper dashboard (day list)
 - Add journey (wizard)
 - Add journey stages (wizard)
- Show-and-Tell 1: MVP Digital Diary

Sprint 3

- Iterative refinement of MVP Digital Diary
- Release to first wave of user testers
- Development of Enhanced Digital Diary
- Meeting with NatCen coders
- Reprioritising Alpha goals to include GPS tracking app prototype
- MVP Digital Diary, iteration 2, including:
 - Shorter (non-hierarchical) URLs
 - After adding a journey, return user to journey view page
 - Accessibility: add hidden "in pounds" to money field
 - UX: show journey stages in tabs
 - Interviewer - add/edit households
 - Interviewer - add/edit vehicles
- Enhanced Digital Diary, iteration 1 deployed, including:
 - Journey and journey stage - edit details
 - Re-arranged journey wizard steps
 - start location/time (step 2), end location/time (step 3) => start/end location (step 2), start/end time (step 3)
 - Added intermediate screen after adding journey, and before adding first stage
 - Interviewer - add/edit Diary Keepers
 - Added form help text from paper diary to relevant fields

- Enhanced Digital Diary, iteration 2 deployed, including:
 - Moved to using Google Firebase for authentication
 - Journey purpose update
 - Improvements to help text and error messages on transport method form
 - Change transport method options
 - Logging form validation errors
 - Added feedback link
 - Added forgotten password user journey
 - Added unit tests, and bug fixes as a result (frontend)
- Show-and-Tell 2: Enhanced Digital Diary
- Onboarding of user testers
- Development of GPS Journey Tracker prototype app
- Internal testing of GPS Journey Tracker app
- Commencement of Alpha report

Sprint 4

- Clarification call with NatCen
- Compliance documentation for GPS Journey Tracker app
- Release of Enhanced Digital Diary to second wave of user testers
- Security and data protection call
- Iterative refinements of Enhanced Digital Diary
- Enhanced Digital Diary, iteration 3 deployed internally, including:
 - Initial work on return journey wizard
- Enhanced Digital Diary, iteration 4 deployed internally, including:
 - Copy change - end location said “choose start location”
- Enhanced Digital Diary, iteration 5 deployed internally, including:
 - Offline mode
 - Repeat journey wizard
 - Improved ticket choice screen:
 - Simplified ticket types list
 - “Return ticket” checkbox
 - “Concessionary” checkbox
 - Add journey summary to journey wizard and stage wizard pages
 - Add back buttons to all wizards
 - Add “Mark journey as complete” functionality (information box and button)
 - Add “Journey purpose” step to the return wizard if the journey started from home
 - Small usability improvements:
 - Meters -> Metres
 - Swap meters and miles on Stage Details form
 - Pre-populate journey end location if journey purpose was to go home
 - Various bug fixes:
 - CSS/JS asset paths and compilation speed improvements
 - Form theme improvements / refactoring
 - GdsNumberType now works with decimals
 - Journey summary stage display
 - Vehicle resolver code.
- Internal testing for new release

- User Research phone meetings with 6 NatCen Interviewers to review Enhanced Digital Diary
- Enhanced Digital Diary, iteration 6 deployed, including:
 - After a journey is marked complete, send the user to the day view screen
 - Repeat/return journey wizards:
 - Update intro copy
 - Move initiation links to the journey view page
 - Remove mention of “London bus”
 - Add dates to day view title and DiaryKeeper dashboard day names
 - Hide ticket price (in stage wizard and journey view) if season ticket was chosen
 - Household edit screen:
 - Fix validation
 - Redirect user to dashboard after editing
 - Add custom 404/500 error pages
- Write up of Interviewer feedback and research
- Alpha report continued
- Release to third wave of user testers

Sprint 5

- Moderating test diaries and off-boarding user testers
- Writing up user testing feedback
- Enhanced Digital Diary, iteration 7 deployed internally, including:
 - Return day and repeat day wizards
 - These allow the return/repeat flows to be initiated on the day view screens and ask the user to choose the day + journey they wish to return/repeat
 - Add a very simple cache for lookup resolvers
 - Journey view screen - If journey has no stages:
 - Add a warning box with advice
 - Disallow marking the journey as complete
- Enhanced Digital Diary, iteration 8 deployed, including:
 - Disable return day wizard, repeat wizard (leaving repeat day wizard and return wizard)
 - Move back buttons to below the title and make the return journey button on the Journey page grey to provide better contrast to the primary action (Add stage)
- Enhanced Digital Diary, iteration 9 deployed, including:
 - Further tests and bugfixes.
 - Journey notifications (disabled for user testing deployment)
 - Stage wizard: Don't collect fare details for taxis
- Alpha report continued

Sprint 6

- Alpha report continued
- Show-and-Tell 3: Enhanced Digital Diary
- Show-and-Tell 3: Native GPS App visual prototype
- GDS Assessment

- Delivery of draft Alpha report

Sprint 7

- Delivery and presentation of final Alpha report

Prototypes

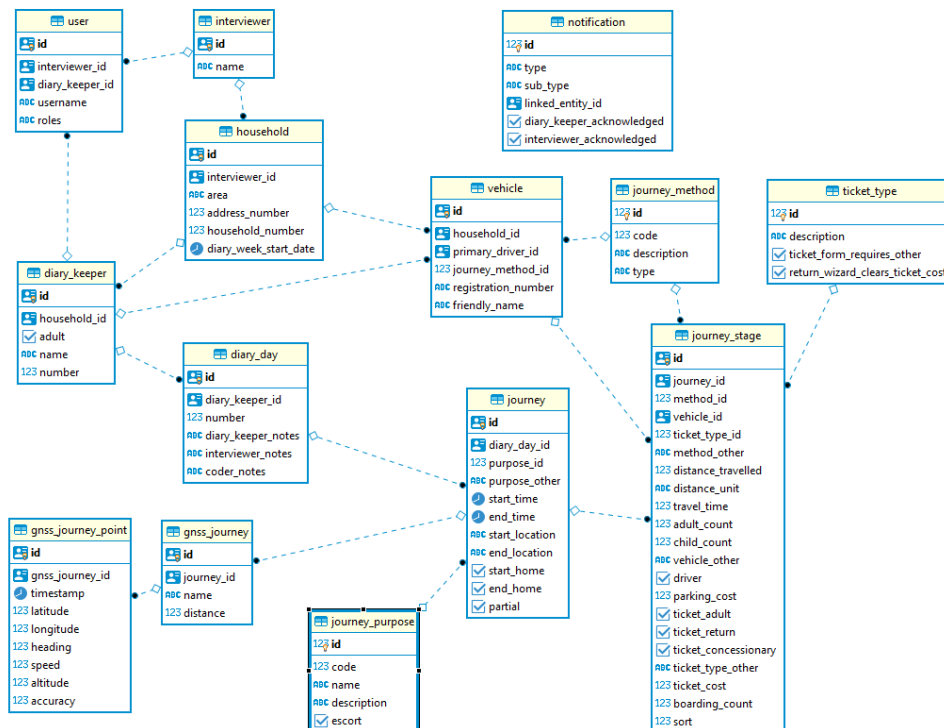
As part of this Alpha phase, we developed and iterated **two prototypes** of the web-based Digital Diary, **one prototype** of the GPS tracking native app, and a **flat (non-functional) prototype** of a full NTS smartphone app.

We created 7 user journeys to meet user needs identified in Discovery. These user journeys were combined into three core service offerings, one for **survey respondents**, one for **NTS interviewers**, who are responsible for onboarding respondents, correcting their data and submitting it for diary keeper analysis, and one for **NTS coders**, who are responsible for coding the paper diaries.

Interviews with NTS data coders validated the requirement for a RESTful API to feed into their existing database architecture for data analysis, while ensuring it aligned to Government Service Standards to ensure future integration with other services and architecture should contracts ever change in the future.

Data Schema

We developed an initial data schema after meeting with NatCen and used this to develop the API and web-based diary prototype. This was then refined and reformed. We then passed this to NatCen for verification and they confirmed that the data schema would be compatible with what they would need.



(Above: Data Schema)

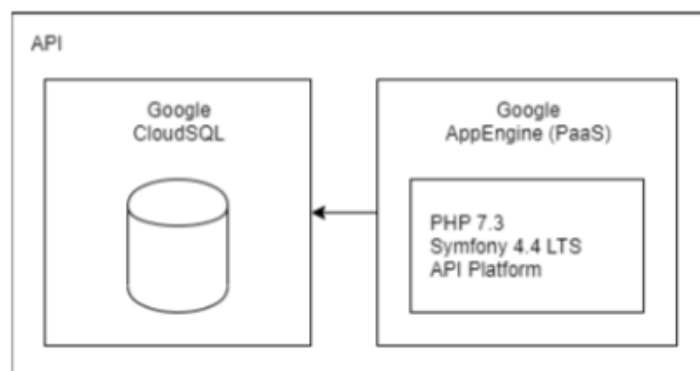
The schema was developed iteratively as development of the API and frontend progressed. The schema diagram below shows the schema as it stood at the end of Alpha development.

For Beta, we suggest that it will need to be extended further to allow coding data to be entered for the diaries.

API

We built the API in PHP 7.3 using Symfony 4.4 LTS with API Platform. In line with DfT Architecture principles, this architecture can be run using Google AppEngine with a Google CloudSQL database. The API was flexible during development with continuous iterations in line with front-end changes.

- REST API
- OpenAPI (Swagger) specification
- User level access restriction / security
- Approved by Architecture Change Board
- Includes space for future geodata development without the need to rewrite schema



(Above: Architecture diagram for API)

A risk identified at the outset of the project, is that the current supplier (NatCen) are using a proprietary legacy system and that integration would result in an imperfect 'hybrid' system that would require redevelopment if another supplier was used, or if the existing supplier changed their system. After discussion with NatCen stakeholders, it was decided that NatCen would be given access to pull data from the API (or directly from the database). This would give maximum flexibility and ensure a commitment to open source and open standards was maintained. NatCen confirmed that this arrangement was acceptable. This is an assumption that would need early testing in Beta in case any corrections need to be made, but the DfT have stated that any future bidders for the NTS survey will need to be able to fit around this system.

We recommend DfT pre-engage with NatCen before Beta procurement about early engagement with the Beta supplier as there will need to be clarification and confirmation that

the data journey can be completed in order to achieve further sign off from the Architectural Change Board ACB and Data Protection assurance, as well as successful Beta progression.

MVP Digital Diary prototype

This prototype builds on wireframes and findings from the Discovery phase to provide an online, digital version of the existing paper diary.

It provides routes for the two key users of the service: the NTS Survey Respondents and the NTS Interviewers.

Features included:

- Interviewer dashboard, to add/edit households and diary keepers
- Diary Keeper dashboard with basic functionality, to allow the addition/editing/deletion of journeys and journey stages
- Pre-populated lists for popular destinations/options to reduce free text fields and reduce Coder burden
- Option lists grouped by category and presenting the most common 'Journey Purpose' and 'Mode of Transport' options to reduce Diary Keeper and Coder time

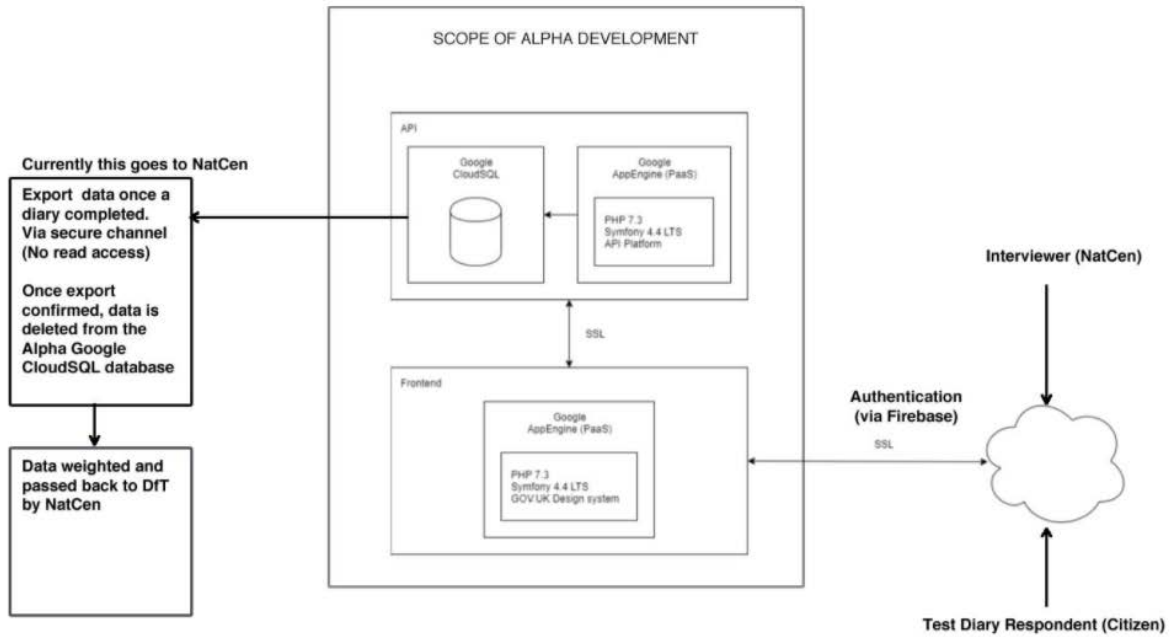


The screenshot shows a web interface for the National Travel Survey. At the top, it says 'GOV.UK National Travel Survey' with a 'Menu' dropdown. Below that, there is an 'ALPHA' banner with the text 'This is a new service - your feedback will help us to improve it.' The main heading is 'What ticket type did you use for this stage of your journey?'. There are seven radio button options: 'Ordinary adult', 'Ordinary child', 'Reduced (off-peak) - adult', 'Reduced (off-peak) - child', 'One day travelcard - adult', 'One day travelcard - child', and 'Other'. Below the 'Other' option, there is a note: 'Including free, concessionary, season tickets and Oyster cards'. At the bottom, there are two buttons: 'Continue' (highlighted in green) and 'Cancel'.

The front end was built in PHP 7.3 using Symfony 4.4 LTS. We used the Government Design System to ensure it was consistent with .GOV.uk. In line with the DfT Architecture Principles and Standards it's served from Google AppEngine, connecting to the API via SSL.

Authentication, again in line with the DfT Architecture Principles and Standards, is carried out through Firebase. To keep aligned with GDS principles we developed Firebase so login could be achieved without javascript.

The prototype was revised following feedback from an initial Show-and-Tell session, and the user flow designed to follow GDS patterns. The prototype had 2 deployed iterations before the switch to the Enhanced prototype.



(Above: Diagram of front end and API architecture, with authentication and data route to NatCen)

GOV.UK National Travel Survey Logout

ALPHA This is a new service - your [feedback](#) will help us to improve it.

What method of travel did you use for this stage of your journey?

- On day 1 include all walks.
- On days 2-7 only include walks of a mile or more. It takes approximately 20 minutes to walk a mile.

Private transport

- Walk
Since this journey is on day 1, include all walks
- Bicycle
- Private (hire) bus
- Car
- Motorcycle
- Van or lorry
- Other private transport

Public transport

- Ordinary bus - London
- Ordinary bus - elsewhere
- Coach/Express bus
- Excursion/Tour bus
- London Underground
- Train
- Light rail
- Aircraft (public)
- Taxi/minicab/private hire vehicle
- Other public transport

(Above: Image of the original 'method of travel' screen in the Basic Digital Diary)

Enhanced Digital Diary prototype

This prototype builds on the standard Digital Diary prototype, but includes a number of additional features and functions to better improve data quality and user experience, while reducing respondent and interviewer burdens and aiming to increase the survey completion rate.

Additional features are:

- Return journeys - rather than inputting the data again, a user can click a button and the outgoing journey is auto-populated in reverse for the Diary Keeper's approval/editing (originally intended for MVP but moved to Enhanced during development)
- Repeated journeys - duplicating journeys that are made regularly (e.g. the school run)
- Notifications
 - Participant - reminder of travel week start
 - Participant - reminders to record journeys
 - Interviewer - diaries not being completed
- Validation error logging - to identify where users are struggling to input the correct data
- Offline usage

The prototype was revised following user testing feedback. The prototype was iterated regularly during the course of Alpha, with 8 iterations being deployed to the test server.

Household	111222/5/1
Participant	Participant 1
Adult/Child	Adult
Day 1 — Thu 9th Apr	2 journeys
Day 2 — Fri 10th Apr	2 journeys
Day 3 — Sat 11th Apr	4 journeys
Day 4 — Sun 12th Apr	2 journeys
Day 5 — Mon 13th Apr	2 journeys
Day 6 — Tue 14th Apr	2 journeys
Day 7 — Wed 15th Apr	2 journeys

GOV.UK National Travel Survey Logout

ALPHA This is a new service – your [feedback](#) will help us to improve it.

[Dashboard](#) > [Household 111222/5/1](#) > [John Matthews](#) > [Day 2](#) > [06:20am: Home to Work](#)

Home to Work

[Back to day two journeys](#)

Journey purpose	To go to main place of work	Change
Start Location / Time	Home (06:20am)	Change
End Location / Time	Work (08:15pm)	Change

[Add stage](#)
[Add return journey](#)
[Delete journey](#)

[1st stage](#)
[2nd stage](#)
[3rd stage](#)
[4th stage](#)

1st stage

Transport method	Walk	
Distance	1.2 miles	Change
Time spent travelling	20 minutes	Change
How many people travelled with you?	1 (1 adult, no children)	Change

[Delete 1st stage](#)

(Above: Image of a multi-stage journey in the Enhanced Digital Diary)

GPS Journey Tracker Companion App prototype

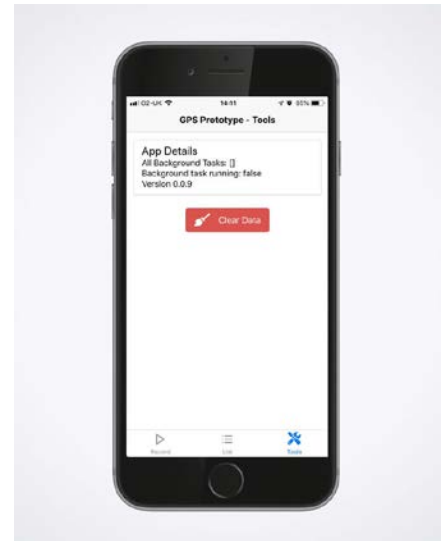
GDS principles strongly recommend that native app development should be avoided unless the case can be made that the required data can only be collected in this way. While the paper diary does collect the necessary information and would continue to suit some respondents better than a digital solution or app, alpha interviews indicated that use of a native app would not only reduce the burden of completing the NTS but also greatly increase take up of the survey among younger participants and male participants, two groups where data quality and survey completion are an issue.

We also considered non-native app digital solutions, such as a progressive web app, but found that browser-based location information (desk-top and mobile) was not recorded accurately enough to be of use when completing the NTS. In addition, the tracking only worked when the browser was kept open and active. In contrast to this, native GPS-using apps record travel data to a sufficiently accurate and efficient level, and at the level of detail required to be useful for Diary Keepers.

This prototype was designed to test some of the concerns surrounding the use of a native smartphone app to conduct the National Travel Survey, and to identify any potential barriers with the use of GPS to collect data.

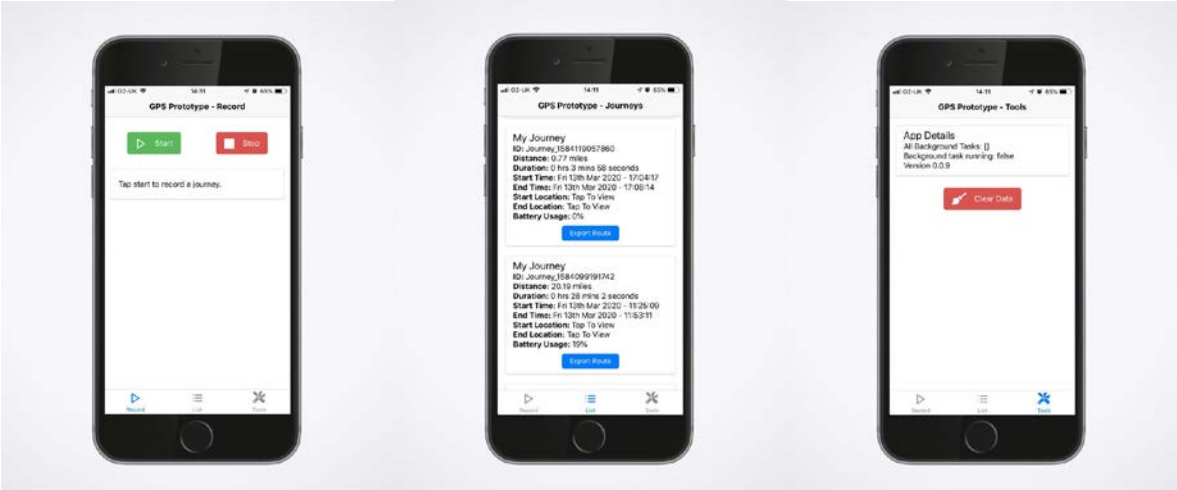
Concerns around the use of a GPS app were:

- Effect on battery life - would running the app in the background drain a phone's battery life to the extent that a user would disable it?
- Accuracy - could a GPS tracker consistently record accurate distances and times, or would accuracy depend on the location of the user and their device?
- Privacy - would an app collect too much detailed location data to comply with DfT security principles? E.g. Is the data you're collecting needed? How could this data be used?
- Compatibility with the NTS - can GPS data automatically populate the required fields in the survey questionnaire? Would it require a prohibitive level of participant intervention to edit the recorded data to fit the survey format?
- Demographics - while the Discovery research and the Alpha user testing indicated that younger/male participants would prefer an app and might be more inclined to complete the survey using one, would we then see a decline in the other demographics who currently complete the paper diaries, such as older people who would prefer the paper diary, or children who are too young to own a smartphone?



Due to data collection concerns, the prototype was limited to a stop/start journey tracker to allow users to record their journeys. The users were limited to Ghost project team members and the app was not deployed to the wider testing sample. The data was limited to the user's mobile device and was not sent or transmitted. The data was then manually cleaned off the device by the user.

The prototype had limited versions, with 2 iterations being deployed to GitHub.



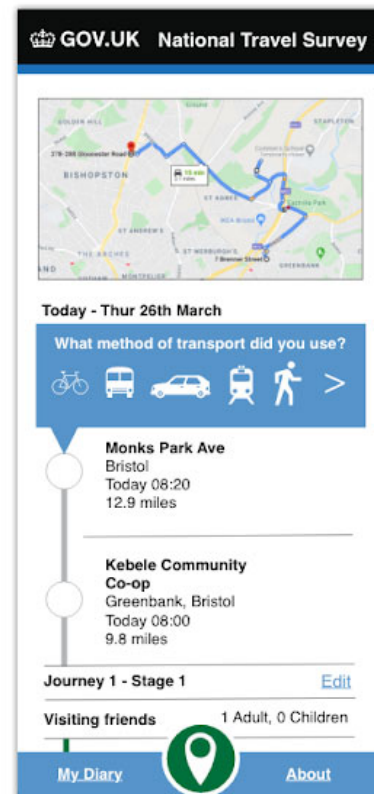
(Above: Three screenshots from the Journey Tracker companion app)

Native GPS App visual prototype

Using Adobe XD, we created a flat prototype with no functionality in order to visualise the user journey for a native app. By creating clickable buttons that move the user around the image mockups we could create an impression of the mobile device in use. This was helpful when sense-checking the design and also useful to show to our user testers to gauge their reactions to a potential app.

Of crucial importance was finding a way of allowing users to input the detail and edit the gathered data to provide what was needed by the NTS so that it didn't feel like a burden to the diary keeper.

Apps such as MoveSmarter in the Netherlands have attempted to utilise background noise, movement patterns and context in order to automatically assign a transport mode. It's deemed to be correct around 75% of the time. The proprietary MyWays travel app, as backed by Hertfordshire Council and made by TravelAI, also attempts to do this, though early testing has highlighted areas where the app becomes inconsistent in gathering the mode of transport, particularly at lower speeds or over shorter journeys.



See [Appendix 6](#) for national travel survey trials and reports in other countries.

For the purposes of the NTS app design, we chose to strip out complexity in favour of a simple and quick interface for users to assign a mode and fill in the details required by the NTS (such as people travelling and ticket details).

Other studies of GPS and smartphone app trials have seen significant dropout due to technical issues with the apps themselves. For example, the Singapore Future Mobility Survey 2012-2013, and MEILI Stockholm study 2016, both had technical issues or periods where the app was not working or was not available (see Danelet/Mathys 'The potential of smartphone data for national travel surveys' 2017⁴). Utrecht University's TABI app also experienced some problems, with 39% of calls to their Helpdesk being made because 'the app doesn't work' and 16% because the app was 'not recording data'. For this reason, we recommend that the app development and testing is kept fairly simple in order to limit the range of technical failure points. Features such as automatic travel mode detection can be developed at a later stage.

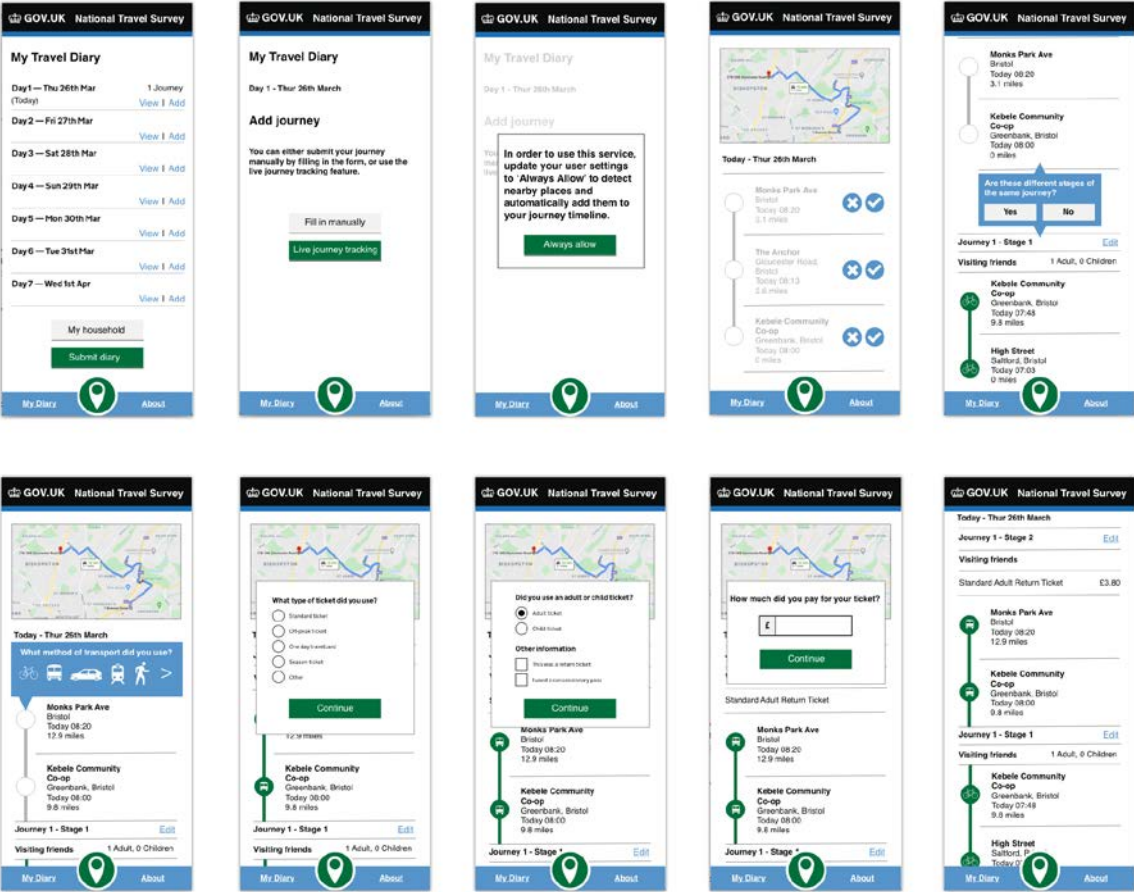
It would also be a good idea to explore the take-up of an app when offered to NTS participants and the completion rate for those who use it prior to full development, as for the

⁴ http://www.strc.ch/2017/Danelet_Mathys.pdf

TABI app ('Feasibility of data collection via a smartphone app' - Lugtig et al, 2019⁵). This could be tested by developing the user interface without performing any data transfer early on, to check user fatigue and identify any issues with the user experience prior to the data architecture being linked up.

With a combination of aspects from the Government Design System and a graphical user interface, the journey we've proposed creates a smooth user flow.

Note: This prototype has not been tested directly by users and their only exposure has been through a demonstration walkthrough on a video, which we provided via a link in order to give the users some reference for understanding how an app might work. This was sent out to eleven of the user testers. Where direct comment on the video came back it was that "This makes it look much easier" and "Although I can see from your demo how an App would be easier, I wouldn't use it because I don't trust the Government not to give my data to private firms or to use it for something else".



(Above: Screenshots from the flat prototype of the proposed app user interface)

⁵ [https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20\(Southampton\).pdf](https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20(Southampton).pdf)

Native GPS App Research

There is keen interest within the Department for Transport to investigate the use of native smartphone apps to record journey data and complete the NTS. This has previously been discussed and investigated internally (a [GPS feasibility study](#) in 2008, a [GPS pilot in 2011](#)), but due to the current GDS policy of “no app by default”, a native app would not seem to meet this criteria at present. However, the possibility should be more fully explored in order to test the viability and potential of this idea while also testing the ability of such an app to pass GDS assessment, as a native app may end up being the only full solution that fully addresses user needs.

In order to use GPS/location services effectively, such a service would have to be housed within a native app, necessitating a separate development stream from the web-based digital travel diary, but still using the same API to collect the data.

The data that’s currently collected by the NTS that a native app could gather is:

- Start location
- End location
- Time spent travelling
- Distance travelled

The National Travel Survey doesn’t currently record exact locations for diary keepers. The questionnaire requires that users partially anonymise the information by recording the approximate area, town or village they were going to (e.g. Hotwells, Bristol, or Leeds City Centre). To pinpoint an exact location using GPS would be a change to the gathered data, which early enquiries with the Data Protection team identified as a potential roadblock to development, as both the amount of data gathered by the NTS increases and the nature of the data (i.e. more personalised) changes.

Rather than go for an ‘all or nothing’ approach to app development, following consultation with Data Protection and the Architecture Change Board it was decided to plan the development of three ‘levels’ of app, in order to test the risky assumptions.

Level 1 app:

Summary: An app that captures ONLY the Start Location, End Location, Time Spent Travelling and Distance Travelled and then keeps it locally on the app.

The user has to start and stop the journey recording process manually. The app doesn’t export any data but the information recorded becomes a ‘memory jogger’ for the diary keeper to accurately track their distances and times. Currently for the paper diary, diary keepers are given a small card memory jogger that they write the distances and times on in order to transcribe later onto the larger paper diary. In this way, this version of the app is a companion app to the travel diary, and it would be up to the user to manually input the information from the app to either the digital diary or the paper diary. The diary keeper can then delete the information and app from their phone at the end of the process.

The downside of this approach is that the user has to remember to start and stop the recording process themselves. From reports of previous GPS tracking studies where users have to manually stop and start a device, it was often forgotten and smaller journeys remained uncaptured. However, this would greatly help diary keepers using public transport to calculate the distance they travelled, which at the moment tends to be a best guess.

Level 2 app:

Summary: An app that captures ONLY the Start Location, End Location, Time Spent Travelling and Distance Travelled, and then exports it via the existing API built for this project.

As with the Level 1 app, the route is used to calculate distance. However, in order to stay within the parameters of the existing data captured by the NTS, it is not exported. The diary keeper would have to enter the purpose of the journey and the method of transportation, tickets bought, how many people they travelled with, reason for travelling, costs of parking, whether they were the driver and which vehicle was used.

They would also have to 'name' the locations (the geodata itself only being used to give an accurate journey time and distance and therefore not exported). The downside of this is that the device would need to 'prompt' the user to do this when it sensed the device had stopped for a certain amount of time, which could be several times during a long train journey. Alternatively, an API such as Google Maps 'Current Place' could be used to suggest names retrospectively.

The NTS information would then be exported via the API that's already been built.

The output of the API would be exactly the same as for the web-based diary and can therefore be ported into that version for the interviewers to moderate and check in the same way. Any changes made by the interviewers would then be picked up by the app. This also ensures the data is consistent in output between the app and the web-based digital diary. As the data is stored in the same place it will be deleted from the database after export to NatCen.

Level 3 app:

Summary: An app that captures the Start Location, End Location, Time Spent Travelling, Distance Travelled, Method of Travel, Tickets Bought, How many people they travelled with, Reason for Travelling, Costs of Parking, whether they were the driver and which vehicle was used.

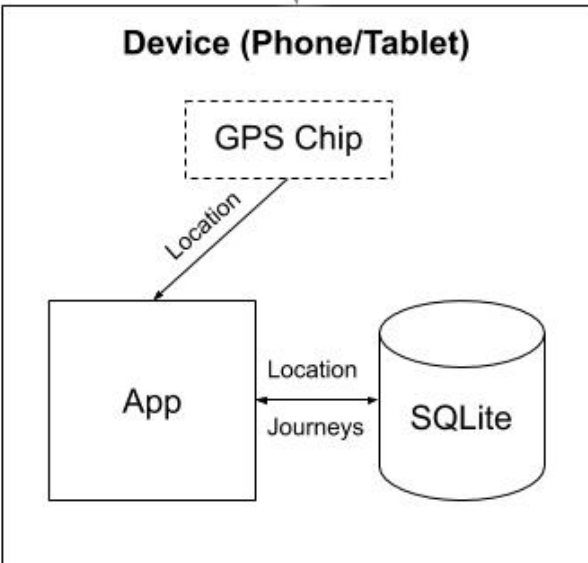
The start location, end location, time spent travelling and the distance travelled are captured automatically by functionality within the app. Using an API such as the Google Maps 'Current Place' functionality, we can present the diary keeper with a series of nearby locations and they can select the start and end points of their journeys and stages. This would then fill in the start and end locations for their journeys. They would need to input their reasons for travel, the ticket types, prices and parking charges, as well as how many people travelled with them etc. This is the same information that the level 2 app uses and would be synced with the digital travel diary and exported to NatCen. However, further data could be extracted concerning routes and exact locations and would be stored for DfT use.

Companion App Development (app level 1)

We developed a prototype of the level 1 app. The user has to manually start and stop the journey recording process. In this respect the app doesn't export the data and it's up to the user to transcribe the information to either the digital diary or the paper diary. The diary keeper can then delete the information and app from their phone at the end of the process.

As the development of a native app at Alpha requires access to a user's phone and explicit permissions to set up there were data protection concerns with using actual user GPS data so we carried out the pre-lockdown testing using the internal project team only. Although many apps are already available (e.g. Expenseln, that captures time, date, distance, etc) it was felt that a bespoke companion app would be a stepping stone towards the ambition of producing a more direct tracking app for the NTS that would pass the data from the Diary Keeper's device via the API, rather than recommending the use of a pre-existing, non-DfT app to record data for transcription by the Diary Keeper.

The native iOS and Android app is built in React Native 0.61.4 with Expo SDK 36 and the Expo application build service. Data on the device is stored using SQLite on both iOS and Android.



All data stays on the device. Diary respondent reads the calculated journey details (duration, distance, etc.) on the screen to aid in filling in the diary.

(Above: Architecture of the companion app prototype)

We chose to use a compiler (Expo) in order to code the app once (in JavaScript) and then compile the code for both iOS and Android. React Native is Open Source and is one of the most used and developed frameworks currently available with most services and APIs

having compatible supporting libraries. Other compilers exist, such as Flutter from Google. The apps could be developed separately in iOS and Android languages. However this would mean writing them twice and having divergent code.

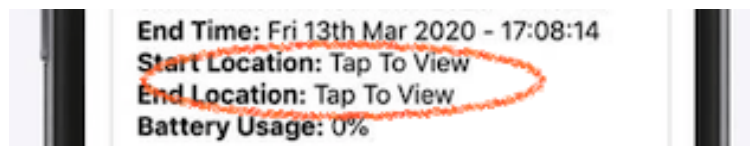
For internal testing, we used Expo but for wider testing we would recommend Apple Test Flight and the Google Play store invite-only beta app service.

For the level 1 app, no external access management is needed as the data is housed entirely on the diary keeper's device. The app is merely a standalone companion to the diary and no data is transferred from the app to the diary except via the diary keeper transposing it manually from one to the other.

The app worked by regularly checking where the device was while the record button was active and recording the location at intervals. In this way, we could ensure we were capturing the route to a standard of accuracy that could be used by the NTS, rather than a straight 'as the crow flies' between the points on the start and stop.

Apps Level 2 & 3 Research and Design

In order for the data to be passed over via the API we'd developed as part of the web-based digital diary, it would need to conform to the NTS data as currently gathered. The level 1 app would only use GPS and location data to work out the distance and times, and so the GPS data it collects to do this has no label outside of the code for geolocation.



(Above: The level one app has no 'label' for the locations)

To pass that directly over to the NTS wouldn't be useful for the purposes of the digital diary, which requires a location label (town, village, or city area). There are two ways of dealing with this:

- 1) A low-tech intervention from the diary keeper to type in a location name for the start and end points of the journey.
- 2) Use a third party API to identify the location or one nearby for the purposes of the location label in the NTS (e.g. a nearby pub or community centre) which the diary keeper could then select.

The problem with option 1, although easier to build, would be that the diary keeper would again have to remember to actively start and stop the recording process in order to log where they were. Available research shows that where participants in tests on GPS device feasibility had to manually control the start and stop, many journeys were missed, or incorrectly recorded. The burden would again fall on the diary keeper and the benefits of automation would be lost.

Option 2 would likely be more user-friendly for diary keeper, but testing would be required in order to ascertain how effective it would be. The downside is an increased and variable cost per transaction as the use of an API such as Google Maps Places (of which 'Current Place' is a component) would require subscription to the service. At time of writing, that cost is approximately 30USD per 1000 requests.

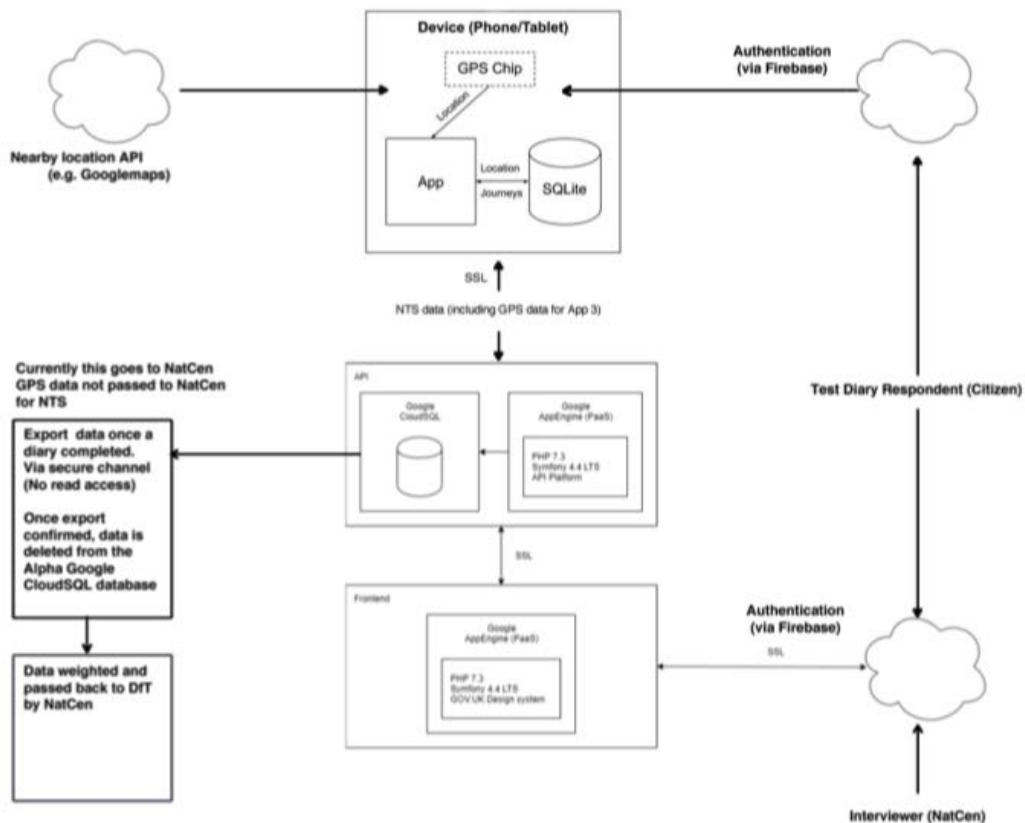
Proposed architecture for Apps level 2 & 3

The native app would pass the information for the NTS via the API built for the web-based diary. In this way the information coming in from the app could appear in the household diaries in the same way it does for a web-based diary. A household could therefore use a mixture of web-based diary and native app, with the native app populating the web-based diary with information, once 'signed off' by the app-using diary keeper. (As we'll see later though, there may well turn out to be issues of the dynamics within the household in terms of who 'manages' the diary keeping and what effect this would have on diary completion, and this would need careful observation and consideration).

The language and fundamental architecture of app level 1 wouldn't change as the app progresses to levels 2 & 3, but the higher levels of app would require authentication, and secure, encrypted data transfer.

At app level 2 no additional data would be taken from the native app other than that already collected by the NTS. The 'nearby location' that's used as a label for the purposes of the NTS shouldn't be precise enough to identify exactly where a diary keeper was, and the actual geolocation data that's used to calculate distance, duration and times of departure and arrival won't leave the phone, having served its purpose it's not recorded in the NTS. The coders and interviewers would know that the duration and distance is recorded accurately from the geodata and the location 'label' that's transported over just gives a rough idea of location.

If app level 3 were to be developed, it needs to be considered where the highest level of collected data would sit once taken from the native app. This is the GPS/route data. Currently the idea is to delete the NTS data from the system once NatCen or a different supplier have taken it for processing. If the DfT requires more granular data for purposes of fulfilling specific requests (e.g. from the department or parliamentary questions) it will need to be stored somewhere in order to be called upon when required. This would need to be very secure with locked down and very limited access.

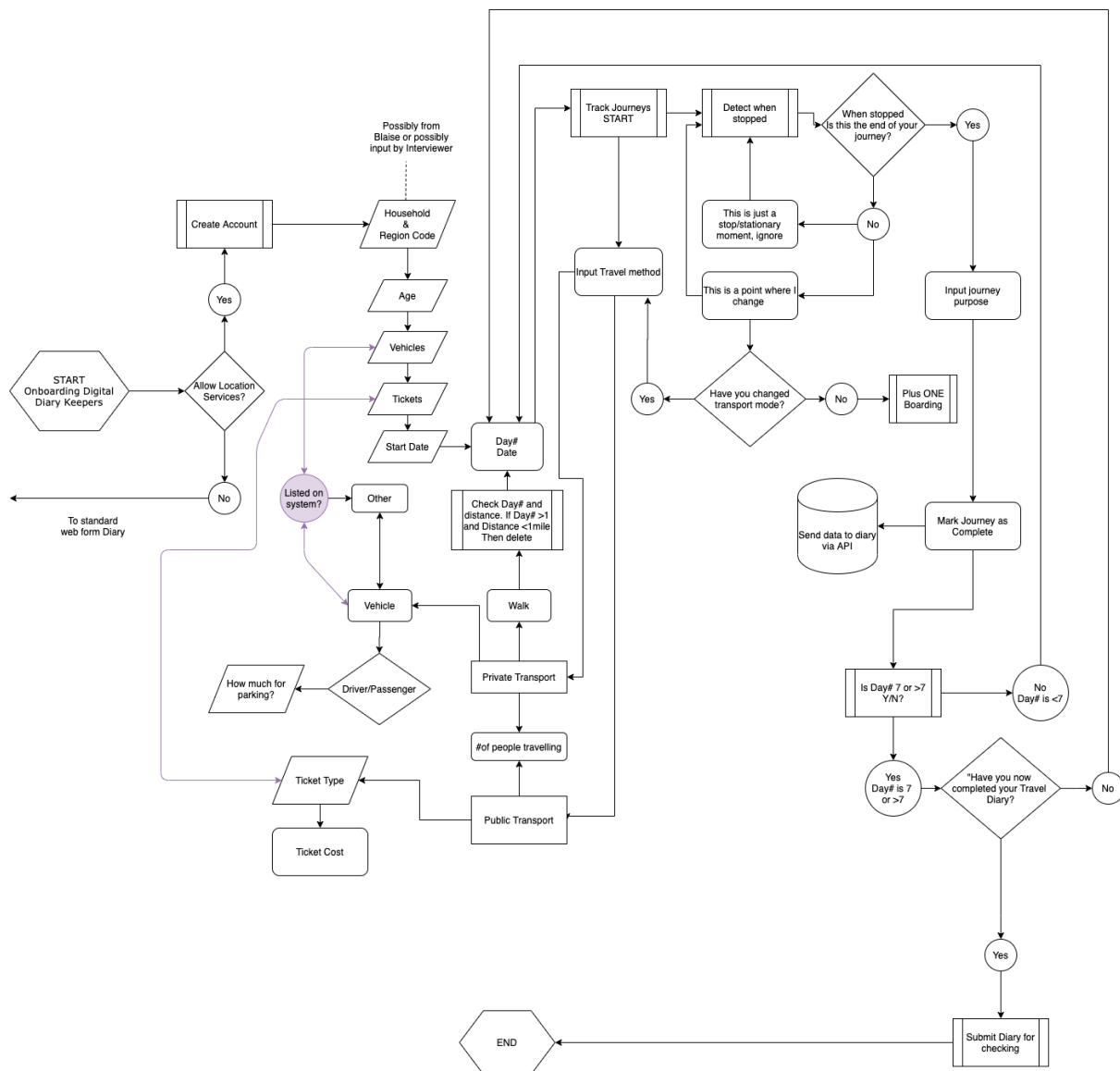


(Above: Proposed full architecture for apps level 2&3)

Design research for full app (levels 2 & 3)

Our user research on what expectations would be for a native app was partially informed by direct conversation with the user testers we'd engaged, but also their experience of using the web-based diary. When asked from cold what they'd expect to see in an app the projected experience was quite similar to the expense app (ExpenseIN) or app level 1. This would need a lot of intervention from diary keepers in order to start and stop journeys, or a lot of notifications from the app, for example if the app senses the user has stopped for 10 mins it might ask if they've reached their destination.

However, a significant minority of our users expected the web-based diary to fill in a lot of the fields automatically, sometimes resulting in unhappy user journeys. These users had asked about apps unprompted, out of frustration. It became clear that any app that constantly intervened to ask the diary keeper for input would be fatiguing. This was borne out by creating a user flow/journey map for a prospective app. The level of intervention needed to clarify what was happening while the journey was ongoing would be highly intrusive and add a great deal of burden to the user.



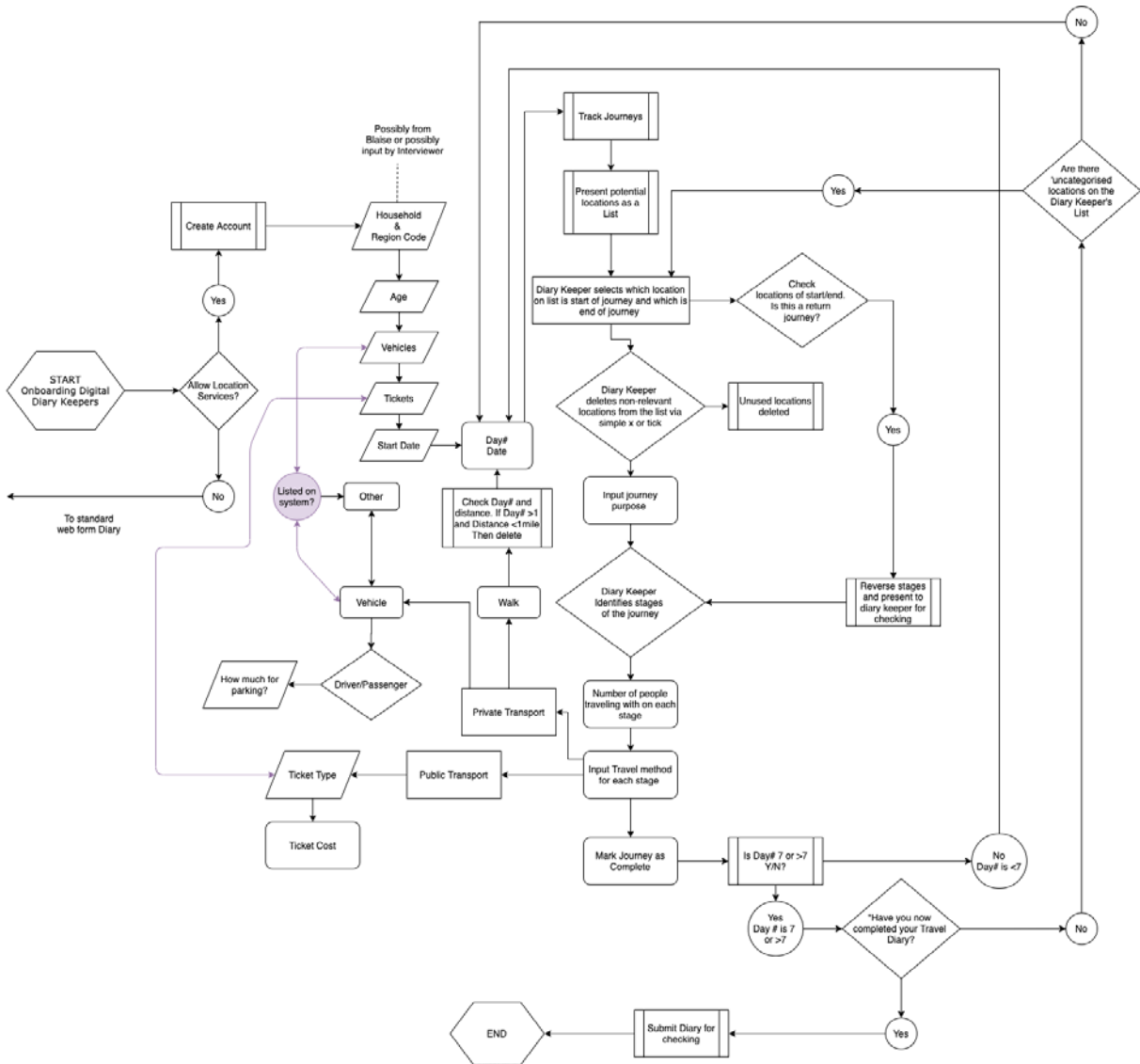
(Above: User flow for live journey tracking - requiring intervention from diary keepers)

Subsequent research into how other apps have handled this issue revealed a convergence of design. From social apps such as Swarm (based on Foursquare) to transport tracking apps such as those tested in Switzerland in 2017, to Hertfordshire Council's MyWays travel survey app (built by TravelAI), the way of recording the journeys is retroactive auditing. That is, the app is always recording the locations and serves them up as a list for the diary keeper to check later, discarding irrelevant stops and confirming visited locations.

The user interface must allow the deletion of a trip, to add one, to group trips (wrongly detected as several trips when they correspond in reality to one single trip) and to divide a trip (wrongly detected as one trip when it corresponds in reality to several trips). It's much quicker to delete a wrongly detected stop via a simple interface than to add one. Trips must be quickly processed to be visible on the device. The detection of stops and locations must therefore be fast, almost in real time and as precise as possible.

This then results in a less 'naggy' application, requiring a lot less intervention beyond the prompts to complete the diary.

The resulting user journey would look something like this:



(Above: Full prospective user journey for app)

Changing attitudes towards Native Apps

Although as previously mentioned the GDS are wary of app development and deployment, and the internal barriers around architecture, security and data protection are high, the coronavirus pandemic may be having an impact on attitudes towards gathering data via these means. At the time of this report's compilation, several apps, branded (rightly or in many cases wrongly) by the media as 'tracking' apps are in development and undergoing testing with a mind towards a fast rollout. Public reaction has so far been reported as mixed, with many people seeing 'tracking' as a necessary part of returning the country to 'normal' and others seeing it as an invasion of privacy and an infringement of civil liberties. On a

microscale, this has been borne out in the responses to our app questions from our users (see [NTS Smartphone App](#)) with some having no problem with their data being used, and others either reluctant, or even very against the idea. As one respondent put it:

“...to be fair Google already tracks my details when I'm out with my phone so in my mind there wouldn't really be much of a difference.”

Conversely, another responded:

“Although I can see from your demo how an App would be easier, I wouldn't use it because I don't trust the Government not to give my data to private firms or to use it for something else.”

Google has recently started releasing [reports based on the travel data](#) it collects⁶, as part of a service to aid with coronavirus planning. Here you can see that Google has inferred people's purposes of travel depending on the locations they're visiting.

However, it must be stated that future public take-up or acceptance of tracking has often been overestimated. Aside from issues around privacy, people are wary of battery drain, particularly on legacy devices, many of which are deliberately throttled to encourage upgrading. There are still a large number of 'hand-me-down' or secondhand devices in circulation and these may have limited battery capability when it comes to tracking in the background in the way an app would be required to do. One user also cited the issue of data:

“I am Pay As You Go and if it needs your data on, this will cost me.”

There is always a level of reticence in downloading government-based apps when they're not mandatory. In Singapore for example, the TraceTogether app to help contact trace coronavirus exposed individuals has only been downloaded by 1 in 6 people, with even fewer of those people actively using it, well below the level of installation needed to make it effective.

Feedback and information on the use of apps by governments in the time of coronavirus is rapidly changing and at the time of writing it's too early to gain any useful information that could be applied to a projected app for the NTS. However, a useful and regularly updated source of information can be found on [Wikipedia](#).

While take-up of an app for a voluntary survey would be less than that of an app to help manage a pandemic, there will be useful learnings for departments regarding the use of apps within government and the data that can be collected. As the crisis evolves and app development by governments accelerates, it will be worth keeping an eye on what's being done in the UK in terms of whether the DfT can utilise any of the data for its own requirements in terms of more granular data.

⁶ https://www.gstatic.com/covid19/mobility/2020-04-11_GB_Mobility_Report_en.pdf

Response and recommendations from the Architecture Change Board, Security Team, Data Assurance and Digital Business Partners

The Architecture Change Board met to review the App proposals. They also conferred with the Security Team, the Data Protection Assurance Team, the Security Team and a representative DfT Digital Business Partner. Their view and recommendation was that although the MVP web-based digital diary should be carried on into Beta, the App should not be carried on into a Beta phase at this stage. Although data protection was an important issue in this, the architecture and the projected data pipeline were also important if not defining factors.

Once a Beta version of the web-based digital diary has been built and, crucially, the data connection between the diary and the supplier (currently NatCen) has been established and fully tested, then a native app will have a foundation to be designed and built onto. Without the architecture established and the data being supplied in a real world environment, there's not enough certainty for the governance teams to sign off Beta development. The merging of the paper data and the web-based digital diary at NatCen also needs to be seen to be working before confidence that there's a firm enough foundation to build in another layer of data is established:

The data processing pipeline for the digital version that integrates data with the data from the paper version of the NTS need confirming and proving before being able to feed into that with a mobile application

More detail required on how data from multiple sources will be merged and what will be done with data when collated.

Detail isn't yet there for how data will work for data transfer for application. Tech is there, but we have not seen that part of the process and how it will work with NatCen.

There were also concerns about the security aspect of a native app, and this would need further exploration, development and testing:

Security review and assurance around app around build needs further exploration and discovery.

Similarly with log on security and DMZ equivalent before transition for repository.

Although the issues around security and the architecture itself could theoretically be resolved with further research and re-submission to the ACB, approval wouldn't be given for app development without an established and working data journey which would only be achieved through Beta development (and in collaboration with NatCen). Furthermore:

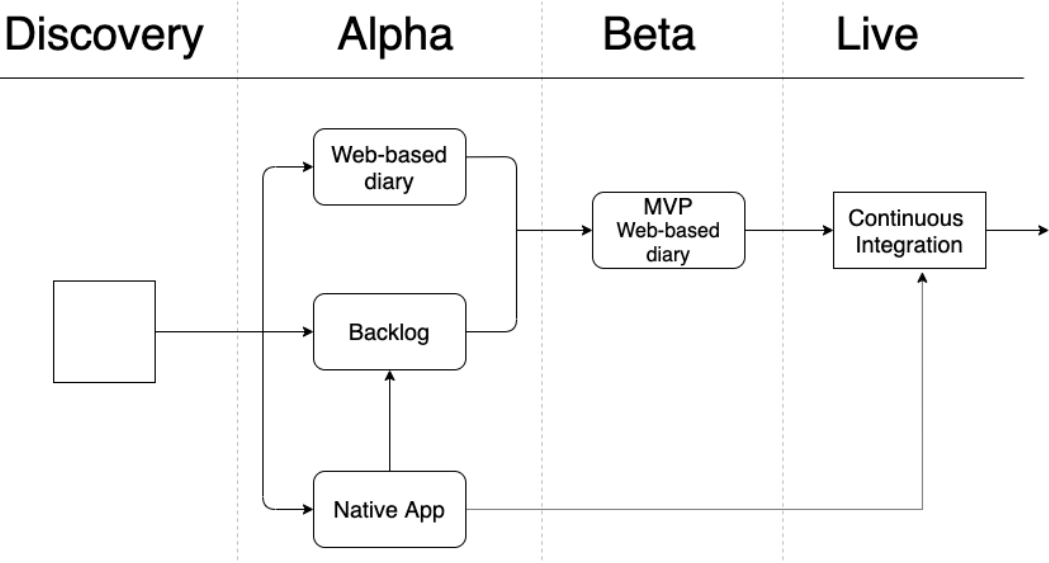
Previous paper [ACB and DPIA Submissions] concerned MVP and alpha. There is a piece of assurance on that, but completed and constrained to alpha. Further DPIAs may be required.

In terms of Data Protection, the level 3 app is in theory the only app taking more data than the NTS currently collects, however, the raw data is still within the app itself, so the security limitations and implications of the app, as it sits on the user device, would need further investigation and testing.

Finally there are also the business changes and costs that app development would bring to Beta. The support mechanism would need to be designed and established, this includes the frontline support from interviewers, but also technical support for the app itself, and its delivery and maintenance within the app stores (Android and iOS effectively). Again this would be better understood once the MVP web-based digital diary is in place, along with the attendant support structure.

Beta recommendations

- Park the app development for Beta and work on developing and establishing the data journey, architecture and processes for the web-based digital diary
- Keep the database and API in a state that can accommodate the location data
- Develop with the mindset that an app could be added into the ecosystem at a later date
- Involve the Architecture team in early plans for collaboration with NatGen to complete the data journey



(Above: Diagram of project development across all phases (based on a diagram by DfT Business Partner))

Further recommendations

- The DfT should roadmap how more granular data fits into the department’s vision.
- The DfT should clarify the data it wants to collect and use from a native app and the purposes it wants them for

- Consider whether a native app might better sit outside of the NTS. For example, the locality of data is currently only added to the NTS when the diary data is put into the DES and the information merged with the survey.
- If a native app is to be developed, then further and early engagement is needed with the DfT Architecture, Data Assurance and Security teams, once the web-based diary Beta is complete, in order to establish what an appropriate architecture should consist of.

See [Appendix 8: Internal questions for the DfT](#)

Alpha Findings Review

This Alpha focussed on learning whether a digital version of the National Travel Survey travel diary improved data quality and made diary completion easier for NTS Interviewers and NTS Participants (Diary Keepers).

These are the 10 key questions we asked of all user research for each user testing stage and prototype iteration throughout the Alpha phase:

1. **Can Diary Keepers complete the prototype digital diaries without onboarding or intervention from an Interviewer?**

Not in its present form. The data required by the NTS is unusually specific and not all data collected qualifies for recording/reporting. For example, on Day 1, all walks must be recorded, regardless of length, but on Days 2-7, only walks of over a mile each way should be recorded. These qualifying instructions are emphasised by Interviewers during onboarding and most diary keepers encouraged to do practice journeys on the spot. Even the most tech-savvy respondents in our user testing groups could not effectively onboard themselves. When given an in-person or telephone interview beforehand, willingness and data quality throughout testing were higher. When left with supporting documentation, most users either didn't read it or didn't read it thoroughly enough to understand the level of information required, instead filling in their digital diaries by instinct and making the same mistakes as paper-diary participants (e.g. not making return journeys). Interviewer feedback suggested that male respondents were more likely to have poor data quality and incomplete diaries, and while that was slightly reflected in the user testing generally, it was exacerbated when those participants were left to onboard themselves. Feedback from these users was that they felt that it should be easy and therefore they made assumptions that what was easiest for them was correct. We had to prompt them several times to read the documentation, and make several further prompts around incomplete days and missing journeys through the testing period. Each diary filled in by our user testers required follow up with a member of the project team to check the data and query anomalies, and it should be noted that only 3 out of 10 new user testers who were onboarded via email had no anomalies in their recorded journey data. This echoed the findings in the Discovery report in regards to the New Zealand trial, which experienced a huge drop in data quality when they removed the Interviewers from the process.

It should also be borne in mind that the role of Interviewer is also that of a salesperson, 'selling' the survey to the household. It is likely that unless the NTS becomes sufficiently simple as to require little or no effort on behalf of participants, the Interviewer role will continue to be the key to finding willing respondents and engaging them.

2. **How much will this version reduce the burden on multi-Diary Keepers?**

The need for individual logins for each household member means that none of the iterations in Alpha reduced the burden for those people completing multiple diaries on behalf of their household. In fact, it increased the burden for some as it required the

management of multiple logins. The requirement to use Firebase and individual email addresses meant that parents completing diaries on behalf of young children found that the digital version was not accessible to them. For Beta, we will recommend development of a household account to allow a parent to input travel data for children under a certain age from their own dashboard.

3. How much will it reduce the burden on Interviewers?

Based on Interviewer feedback, while initially there is a little more work required to set up the household, it vastly improved the data they received and they needed to make fewer corrections to the journey data at the end of the week. They could also review the diary keeper data remotely. The notifications for both diary keeper and Interviewers also alleviate some of the burden on both. However, they mostly still felt that they would need to review the data with the householders present.

4. Are we getting more data and is the data collected more accurate than the paper diary?

Based on Interviewer feedback, the data collected by the Enhanced Digital Diary is more complete. Prior to development, consistent feedback was that return journeys were often missed and so that was a significant improvement in their eyes. The number of return journeys increased due to the addition of the 'Add Return Journey' button and the reverse copying of the journey stages. One area where data can't easily be improved is in regard to journey time and distance, as those fields still require the Diary Keeper to manually note or find that information prior to recording, and this would always be the case with the web-based diary. However, when a completed diary was reviewed by a Coder, they found the data to be notably more complete and accurate than a typical paper diary.

5. Does it reduce the levels of manual intervention to validate the data?

Yes. All Interviewers agreed that there were less user errors on the Enhanced Digital Diary than on the paper diary. The digital process also removes the burden of handwriting interpretation.

6. Can a physical 'pick up' be removed from the process?

Not immediately. While the digital diaries were more complete, almost all travel diaries required some form of correction or in-person prompting post-survey. Most Interviewers who took part in our testing felt that an exit interview would still be required, although trials could be undertaken to test a 'remote' exit interview, with Interviewers reviewing the diary and posing any questions over the phone.

7. How much can the manual Journey Purpose coding be removed from the process?

There are 23 codes for the Journey Purpose, some of which overlap (e.g. *Personal non-medical* overlaps with everything that isn't medical). We tested the initial build with all 23 coded Journey Reasons on display, but it had the effect of paralysing some of the phase 1 user testers. After talking to a coding/keying representative at NatCen, it was apparent that there was a particular group of codes that came up a lot more often than others. We chose these to be the main purposes on display that receive a code as soon as the method is selected. We then added an 'Other' option

with a free text box to allow coders to input codes in those instances.

When reviewing a completed digital diary, a Coder remarked that the data quality was much better than they usually saw with a paper diary. Data entry and coding accounts for less than 10% of the total cost of conducting the NTS. Therefore efficiency improvements may potentially be able to reduce costs, although not substantially enough to boost the sample size.

There is currently no place in the paper version of the coding process to insert machine-learning or automation. The codes are written directly onto the diaries and then the keyer enters *only* the codes into the Diary Entry System. The original entries that the diary keepers wrote in are not recorded. By replicating the coding process on the digital version of the diary, both the original diary keeper entry *and* the code would be kept. There would therefore be potential to integrate machine learning at a later date, with the coders ‘teaching’ the system how entries should be coded.

8. What is the preference (or not) of users towards a digital diary?

Prior to user testing, the Interviewers all predicted that there would be a generational split in paper vs digital for the survey. Alpha user testing showed that some older participants (i.e. over 65 years old), regardless of whether they had additional needs, did struggle to complete the digital diary, but that they were just as keen as younger users to use a phone app. When surveyed, there was no notable weighting towards older participants in terms of paper preference, with 3 out of 5 users over 65 years agreeing that an app would make the completing the NTS easier. Notably, all 6 of the previous diary keepers preferred the digital version or found it easier to fill in, but that is within the context of having already filled in the paper diary for a week. The majority of NTS respondents taking up the digital diary in the future will not have any previous experience of the paper diaries. Larger scale research in Beta should explore this research question further.

9. What will the impact be on sample size (based on the insights from the other questions)?

From other studies, we can see that the response rates for apps are sometimes low (e.g. Dutch TABI app showed a 26% sample response compared to 33% for their web-based diary⁷). Among previous keepers of the paper diary, there was a clear preference for the digital diary experience in terms of convenience, but as most NTS respondents will not have this comparison, this is not necessarily a useful metric.

To achieve a meaningful response to this question, we would need to test on a wider scale in Beta and, crucially, develop and release the system that allows a designated household diary keeper to access and fill in the diaries from other household members. The evidence provided by interviewers shows that there is often one person in a household who takes charge of the diaries and this will have an effect on whether the diaries for the whole household get filled in or not. The assumptions about responses by gender and age would also need to be further tested in private

⁷ [https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20\(Southampton\).pdf](https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20(Southampton).pdf)

Beta, and the sample size expanded and monitored in public Beta. It's worth noting that the Discovery report concluded that a digitised version of the diary would not increase sample size significantly on its own, whereas the development of multiple digital methods was more likely to achieve this.

10. Is there sufficient value to warrant integrating the digital diary with the interview components?

We believe so. Due to the generational split in digital confidence and technology habits/access, plus the gender split in data quality, it could take some time before the paper diary and in-person onboarding process would become redundant. If a full, native app version of the NTS were to be developed in the future, the paper version would still need to be run for a significant period of time in order to collect data from older demographics and to manage the continuation and integrity of the time series.

Enhanced Digital Diary Testing Outcomes

We carried out several rounds of interviews with both NTS participant testers, NatCen Interviewers and NatCen coders, and recorded their feedback and responses to the survey, both generally and in specific relation to the Digital Diary version.

NTS Interviewers (NatCen)

At the beginning of the interview, we made it clear that the Digital Diary was to supplement the paper diary and not intended to replace the interview process. All 6 of the NatCen Interviewers we spoke to had been conducting the NTS for several years, and they all made similar observations regarding the paper diary and the participant responses to it.

Key Testing Outcomes

All Interviewers agreed that the Digital Diary would make diary moderation easier and encourage better data quality.

All Interviewers thought that the Return Journey functionality had the potential to reduce their moderation time, particularly amongst younger respondents.

All Interviewers agreed that the ability to send notifications and prompt messages to participants would improve diary completion rates.

Gender

There was a noted gender split in terms of willingness to record journeys and the quality of data received. This was observed by all Interviewers.

“Men are rubbish at filling in the diary. We get much better data from the women.”

“It’s always the women in the household who fill in the diary, usually for everyone. Men just don’t do it.”

Age

All the Interviewers agreed that older people would prefer to keep the paper diary. Some identified that age as over 65 years others as young as 50 years.

“Kids love filling in their own diaries, and earning a voucher for it.”

“When asked whether they’d prefer to do the diary in paper form or online, it’s a real generational split. Everyone over 50 prefers paper, while everyone under 38 would prefer to use an app or online.”

Sign up

When asked whether it was difficult to get people to agree to fill in the diary, they all agreed that it was quite easy, especially once the initial hour long interview had taken place.

“Everyone says they’ll do it.”

"You're forming a relationship in one respect - you sell yourself before the diary. I tend to mention that we're doing the diaries before we start the interview."

"All quite happy to do it, no problem getting people to do it, but the data quality this year seems to be worse than previous years."

"By that point they've talked about the travel patterns and formed a rapport, I usually introduce the diary as information that will go to the DfT and inform them about travel issues - this is your opportunity to demonstrate the problems you're having. You have a back story and can tailor what you say focussing on what they need to complete based on their own travel experience."

Data Quality

We asked the Interviewers which areas of the diary caused the most trouble in terms of participant understanding, missed details and mistakes, as well as absent data.

"Biggest issue is return journeys, definitely."

"The single biggest mistake is people filling in Day 2 on the remaining Day 1 pages."

"The difference between stages and trips is a nuance people find tricky. Also round trips like walking a dog in a circle or a run."

"Number of passengers, tickets, parking, that secondary level of detail."

Moderation

All Interviewers check the diaries, usually at the point of collection, before they leave the household. We asked whether they corrected the diaries before they took them away and/or sent them off.

"It does vary a lot, I generally sit down with them and go through it, there might be some anomalies - variations between parents and children on the diaries, things not quite matching."

"I always go through the diary with the people there. Always. So much easier."

"It depends, some people are meticulous and you can have minimal effort of checking. Sometimes you need to go through line by line. It can be three or four minutes or it can be half an hour."

"Yes, definitely. When you've done it a while, things look normal or they don't. But within reason, we don't want to stay for ages when we say we're only just picking them up."

Encouragement

We asked how much encouragement was required to keep the participants on track and in a position to complete the diaries.

“Differs from person to person. 80% of the time, we don't have to do much. We ask them if they want the mid-week phone call, and lots of people say 'no thanks, we're fine'. In my experience, if they agree to do it, they do it. No chivvying required.”

“Getting the detail right in the diary itself, as their responses vary. The way we shepherd that through in the week is vitally important.”

“This is why the mid-week check is so important to keep the motivation.”

Recommendations for Beta research:

- Workshop with Interviewers and the NatCen regional managers to identify key issues in workflow changes, the requirements for skills transfer and expose the prototype to a wider base of Interviewers
- Make changes based on that feedback
- Arrange training and skills transfer so Interviewers are equipped to onboard and support diary keepers
- Include a digital practice day to allow Interviewers to take participants through a practice journey or two prior to starting the diary
- Explore improved messaging to support journey stages and modes of transport

Survey Respondents (Diary Keepers)

We spoke to 19 new Survey Respondents who had never participated in the NTS before. We wanted to test the usability of the Digital Diary and discover whether data quality would improve. Due to social distancing measures, we provided some dummy journeys for them to input, and also asked them to invent their own dummy journeys based on a typical day.

We also spoke to 6 previous Survey Respondents, 5 of whom had previously completed the paper version of the diary. 1 had started the paper diary but not completed it.

Key Testing Outcomes

Most Participants agreed that keeping the travel diaries was “a bit” or “pretty” burdensome.

All New Participants that tested both agreed that the Enhanced Digital Diary was “much better” than the MVP Digital Diary.

“Repeat journey functionality was an improvement. Stages a lot clearer now.”

“The return journey button is good and saves a lot of hassle.”

All Previous Participants agreed that the Enhanced Digital Diary was easier to fill in than the paper diary.

“Very easy and quick to use took 5 minutes to enter a full day journey, paper one you could forget about or make a mistake easily.”

Some Previous Participants felt that the Digital Diary was quicker to complete than the paper diary.

“The online version was far quicker to complete as it remembered locations used as well as other things, like vehicles and train tickets. Understandably, it was also easier to correct mistakes.”

New Participants expected more automated completion by the Digital Diary. E.g. Use of postcodes to auto-populate distances, use of start/end times to auto-populate travel time.

“I also didn't understand why the online version couldn't have calculated the time travelled from the information entered.”

Some New Participants were unused to self-anonymising location data (e.g. replacing postcode with ‘Friend’s House’) and found it counterintuitive to do so online. This was not the case with the Previous Participants, most likely because they already knew the data that was required by the diary.

Most New Participants did not read or fully read the instructions or accompanying documentation prior to filling in fields, relying on memory of the onboarding interview, instinct and validation messages to get things right.

Gender

We enlisted 11 male and 14 female participants for the testing and found that even in a small sample of willing volunteers, there was a small gender split in terms of recording rates and diary completion. There was no difference in the availability of the participants during the testing period to account for this. The difference was more marked in the new diary keepers than in the previous diary keepers, who had a better understanding of what was required.

2 of our 14 female testers, both with anxiety disorders, dropped out of testing after onboarding.

12 out of 12 active female participants started and completed their diaries, while 1 of our 11 active male participants started but did not complete the diary.

4 out of 11 male participants had to be contacted at least once before they completed the diaries. This was in contrast to 2 of 12 female participants.

There was no real gender difference in the ability to complete the diaries or understand the instructions. 5 out of 11 male participants and 7 out of 12 female participants had to have their diaries corrected after review. The female participants were more likely to have mistakes within the data (e.g. adding non-qualifying walks) while the male participants had more missing data (e.g. return journeys, blank days).

Age

Our participants were aged 15 years to 72 years.

There was no difference between the participants in terms of being able to understand the Digital Diary or what was required in terms of age.

The one outlier was the oldest user, who also described herself as “digitally unskilled”. While she required detailed telephone assistance in order to complete several practice runs, she was then able to complete her diary unassisted and with no corrections.

Contrary to the preferences predicted by the Interviewers, there was no difference between our participants in terms of preferring a paper diary over a digital diary, with 3 out of 5 users over the age of 65 years saying that they would find an app useful, although 2 had caveats:

“An app that automatically tracks would be far easier... the only thing is, I don’t always carry my phone with me.”

“App sounds very simple, however I’m slightly wary of increasing tracking as creeping into privacy of general public.”

An interesting point to note from the above is that 2 of our older respondents said that although they have a smartphone they don’t always carry it with them. A subtle distinction needs to be made between smartphone ownership and the kind of easy-access and ubiquitous smartphone use that most young people take for granted. Further study is needed as initial searches found only localised studies into smartphone use in the elderly (e.g. Malaysia or Saudi Arabia). Most recent studies focus on either smartphone *ownership* or the usability of smartphones for the elderly, rather than how much they are used.

Onboarding

All participants began the diaries the same day as receiving their links and were happy to get started without any walkthroughs. However, those who received no onboarding made more mistakes and required more diary corrections when the testing period was up than those who were onboarded either in person or over the phone.

Those that received an email containing the same information as the phone call (i.e. left to onboard themselves) were no better at completing their diaries than those who received no onboarding at all, and in some cases admitted that they had not read the documentation.

For example, almost all those who received the email continued to include journeys of under a mile for the duration of their diaries.

Validation Error Logging

The NTS requires a certain amount of translation from real journey data into the data requested by the questionnaire, and so mistakes are extremely common in the paper diaries. [Validation errors](#) on the Digital Diary journey input forms have been helpful to pinpoint common misinterpretations and inform guidance messages to help users.

In our first wave of user testing (6 participants) on the Basic Digital Diary, the most common error was “Enter the number of people who travelled with you”. The assumption was that this

field meant 'additional people' and so anyone travelling alone left it blank, while those travelling with others discounted themselves from the number. We subsequently changed the label to "How many people travelled, including you?" and added further guidance, explaining "Please enter the number of people, including yourself, who set out together" which reduced the number of errors by 80%.

In the second wave of user testing (13 participants), on the Enhanced Digital Diary, which included the first 6 participants and another 7 participants, the most common error was with the time entry field - inputting times using a 12 hour format. While this was in line with research from the Gov.uk design system backlog, most participants expected the field to be 24 hour or to accept a 24 hour format as well. This was supported in the third and fourth wave of user testing, with 10 of our 29 active participants specifically requesting a 24 hour clock field during the exit interview.

Accessibility and Additional Needs

2 of our participants were dyslexic (1 adult, 1 child) and struggled to comprehend some of the instructions without assistance, or miss-read button text. In one instance, once the user had managed to complete an accurate multi-stage journey however, they required little or no intervention in order to complete their diaries.

1 of our participants had low digital confidence (reluctantly online) and required detailed telephone assistance to complete several practice runs. Once these were completed, she was able to complete her diary alone to an excellent standard.

2 people who suffered from anxiety disorders dropped out of user testing after receiving the onboarding instructions. No specific reasons were given, only that they were now too busy.

1 of our participants had autism, fibromyalgia and mobility issues. They had no issues in using the Digital Diary, but did have issues converting their journeys into stages for the NTS.

Recommendations for Beta research:

- Test different data input fields to inform best choice for user experience (e.g. 12 or 24 hour clock field)
- Add journey sharing functionality to reduce diary keeping burden within the household
- Allow the main diary keeper access other household diaries
- Explore the use of mapping software to allow users to plot journeys and to auto-validate journey distance
- Design a prompt/help system to assist with diary completion
- A/B testing on wording to inform the best descriptions for questions and fields
- Further accessibility testing (see [Accessibility](#) recommendations)

NTS Coders (NatCen)

The Product owner and Delivery manager spent several hours at the NatCen offices in Brentwood in a face-to-face meeting with an experienced NatCen coder and keyer. We were able to look at some of the actual filled-in diaries that the coders receive, and see the codes. We could also see the level of moderation/sense-checking that goes into cleaning the data

even before it's put into the Diary Entry System. As well as looking through batches of diaries, we were given a demonstration of both the coding of the diaries and the keying into the system.

From looking at the diaries we could see the practice page that's usually done with the interviewer there. The supplementary day one pages are often folded down at the corner by the Interviewer to stop them accidentally filling in Day 2 on them - but this still happens often and can make the physical diaries very messy and hard to read.

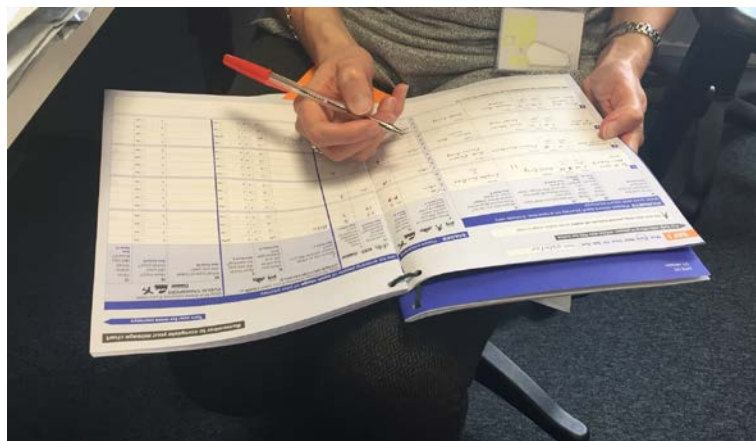
Diaries are first moderated by the interviewers. They try to arrange it so that Diary Keepers use black or blue pen. The interviewers sit down with the Diary Keepers and go through everything in the first instance, Interviewers use green pens and Coders use red.

Diaries arrive from the Interviewers grouped by household - bound together with hole punch and document string tags, and sealed in plastic envelopes. There might be 4-5 Diaries in a household.

The gap between completion and opening at NatCen is 2-3 months (at the time of our visit (Feb) they were up to December's diary). They put together a 'batch' of 10 households and group them by area to make the checking easier. It might take one hour to code a batch of 10 households and up to six hours to key in the same batch, because of the amount of checking they do. They do something like 40 households a week, which might be 100 diaries per coder/keyer.

When the coders, who are mainly freelancers, open the diaries, they perform a quick visual check, checking the start date is right and that the diary is completely filled in. They do get a lot of households where not everyone in the household has completed a diary which means that's a partially completed diary. They put through partially completed diaries, but they're not used for the data that goes through to the NTS team.

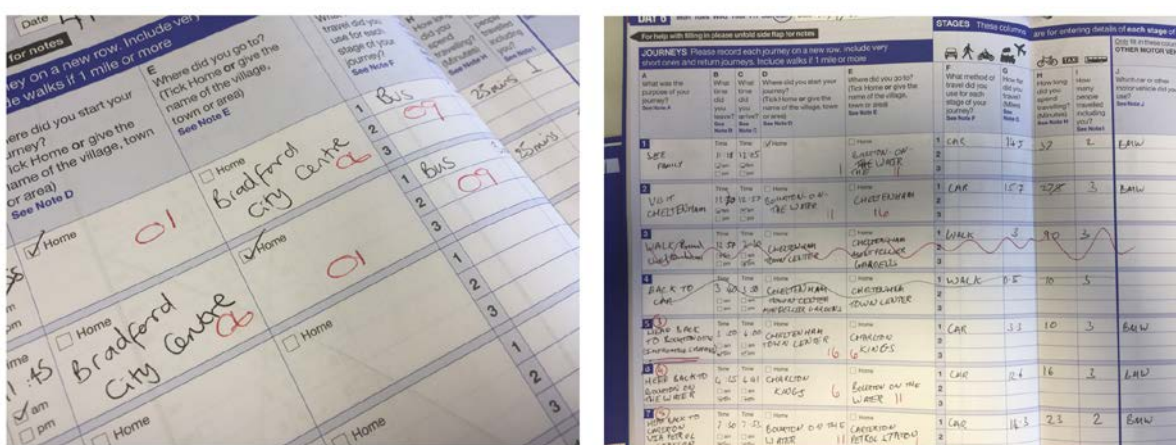
They'll then simply fill in the codes directly onto the paper diary itself.



(Above: A coder filling in the codes directly into a diary)

Particular challenges the coders face

- Tickets are one of the biggest issues for reconciling with the survey. There's often a disparity between the tickets the Diary Keepers say they have in the interview and the ones they record in the diary. Dividing the costs between the return for example.
- Oyster cards: Diary Keepers often put nil for the cost because they don't know how much has been charged. Coders look up the costs of the various ticket types and they have a spreadsheet printed off displaying the various options.
- Buses are another huge problem. It's very hard to work out from context what the actual bus status is. For example, a chartered hired bus, or an excursion, or a school or club minibus.
- Under 50 yards is not recorded at all (often people write down that they walked from the car park to the office, for example) and these are crossed out.
- Some of the codes are a fallback for when Coders can't extrapolate what the Diary Keeper was doing from the diary. For example, 'Personal non-medical' is only used when the Coder can't work out what the purpose actually was.
- Anything under a quarter of a mile gets turned into yards and the Coders have a cheatsheet for that.
- They strike out any walks that are too short. People very often hugely overestimate the distance they've walked, and the time taken will not match up with the distance. Usually, Coders will take the time as accurate and adjust the distance accordingly. This will mean that many walks then fall under the category of being too short to be recorded as they're under a mile. It can also be a problem with those people recording runs, as the Interviewer will need to add a note to explain to Coders and keyers why the distance might be further than the time suggests it should be.
- Sometimes Diary Keepers won't put in stages to begin with, treating something as a whole journey, then realising and trying to correct the diary.
- People often forget to include themselves on the 'How many people travelled with you (including yourself)?' question.
- People tend to put 'Home' to 'Home' for journeys with no specific destination e.g. cycling for leisure. Can be really hard for Coders to establish a mid-point.
- People's handwriting can often be very hard to understand.



(Above: Two examples of diaries with codes. Right: non-qualifying journeys crossed out)

Of interest to the DfT is the small box which is provided for notes. There were cases of participants adding context that was potentially useful but not captured in the database e.g. saying they didn't travel that day because they were sick. There is interest in DfT about non-

travel, as it may be an indicator the transport system is considered inaccessible for people with disabilities or that there may be potentially useful routes that public transport is not serving, but this isn't captured currently. Nor is it in the data by the time it reaches the NTS team at the DfT.

Example of text written in diaries:

- Go for lunch
- Delivering Christmas present/cards
- Hairdresser
- Football
- Night out
- Drive with mates
- See my boyfriend
- 'Birthday' interviewer added 'to see my son'
- Drop daughter off (coders checked daughter's diary to see what daughter did)

Keying in the diaries

When they come to key in the diaries to the Diary Entry System, the codes from the diaries will be matched up to the survey and now the home address and other information will be blended with the data from the diary.

Coders will try and narrow down the locations in order to test the distances. So not just Bristol for example, if someone has said they've gone to Aldi and it was two miles from their home, the keying in staff will look to see where the Aldis are in that range and will edit the distance or time accordingly. They use the information in the questionnaire to work out and extrapolate the distances and locations. The Diary Entry System also flags any disparity in the time/distance - say for example if they say they set off at 6:15 and arrived at 6:30 but then say the journey took 40 minutes. There is some validation on the DES, for example if you enter 'Underground' in Bristol, it won't allow it, because there isn't one.

There's a lot of knowledge that the keyers/checkers use - such as the distances, fare types, ticket changes. Extrapolating that something is a return ticket for example and whether the travel was made at peak times.

Very often they make judgement calls when reorganising journeys - for example people treat a journey to work where they drop the kids off on the way as a journey to work - not a journey that was escorting and then another journey on to work, so Interviewers, coders and keyers will split them out.

People do a lot of "ditto" or "as day one". The Diary Entry System does allow them to repeat or duplicate a journey in a household and change the passenger status and the code. The repeat is for a journey by the same diary keeper, duplicate is used for the same journey made by a different member of the household.

The Diary Entry System has a system called The Gazetteer, which is a database of locations and helps them to input the locations. So for example if someone has put Home to Hotwells, they can type Hotwells into the destination field and it brings up a list of suggestions, including Hotwells, Bristol. The Gazetteer is however out of date. A lot of the locations they

can work out by knowing the home address from the questionnaire and then having google maps open and looking for the locations on the map. The questionnaire will more often than not also have the work address, so the keyer can use that.

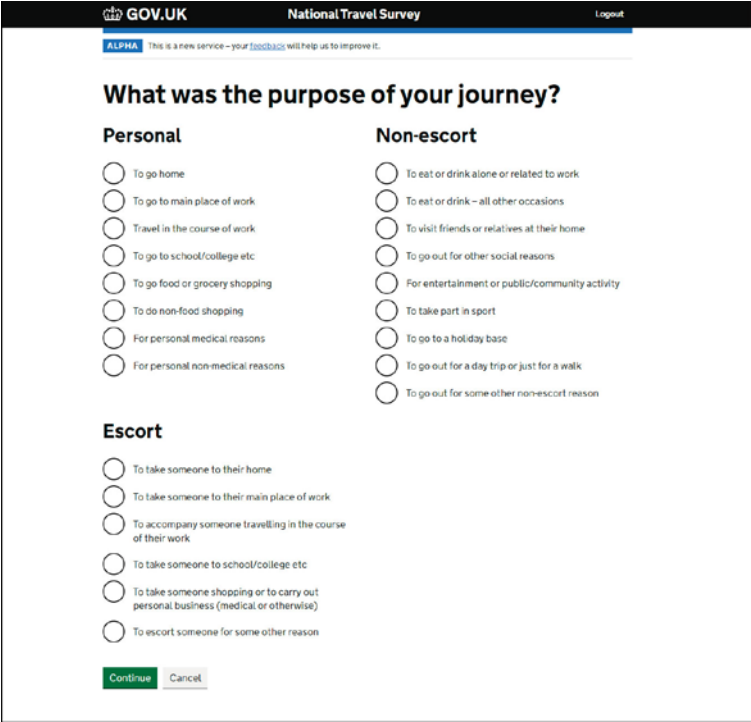
For the sake of speed the keyer will often record distance as the crow flies, especially for train journeys - people find it very hard to say how many miles they've gone by train.

They will often group a series of journeys into one journey, for example people often say they were going round shops for 3 hours and treat that as several journeys, that'll be coded as one journey.

There's a new Diary Entry system being tested and NatGen hope to have that up and running by the time they come to input January's diaries.

The prototype

The interview and discussion with the coder gave us the main journey purposes and some information on potential arrangements for the ticket and transport type selections and this was used to inform the design on the prototype. For example, our very first prototype listed all the codeable options for journey purpose, which was 23 options, too much for people to deal with (and because some of them were fall-backs if no other purpose was obvious, they often overlapped).



(Above: An early iteration, with all the possible codable journey purposes on one page)

After the coder interview, we were able to choose the six most likely journey purposes which would be coded if someone selected them, and then an 'Other' field with a free text box. In this way we hoped to capture around 80% of the journey purposes and give them codes

within the system. After we had built the prototype and gathered enough user data, we created a view that would allow an 'at-a-glance' view of a week of diary input. These were then screenshot and sent to the NatCen coding team for evaluation. The result was that the data was all understandable and codable:

*All details, purpose, times, etc can be seen clearly.
I wish all diaries looked like that!*

Conclusions

One of the key questions asked at the outset of Alpha was:

How much can the manual journey purpose coding be removed from the process?

As there are 23 codes for journey purpose, simply putting these up as options on the screen for diary keepers to choose didn't work. There were far too many and some of them overlapped (often because they were fallbacks such as 'personal non-medical' which could for example be the same thing as 'visiting a friend').

After guidance from the NatCen coding team, we selected and presented the label for the few codes that most people use (based around the 80/20 principle, that 20% of any set would cover 80% of the occurrences - it may not be exactly 80/20 for Journey Mode but the principle is the same) and include an 'Other' field with free text for diary keepers to fill in. This way the journey purpose should largely be coded correctly at source, with the coders only needing to code the 'other' entries. From the test data we sent to the coder, the legibility of the inputs (being digital) combined with the at a glance context meant the coder was able to very quickly code the data.

We recommend building a coder's dashboard and log in so the coding can take place on the same system. In this way the data would have codes assigned to it on the same database. The benefit of this is the interface gives the potential for adding machine learning at a later phase, whereby the coder inputs can 'teach' the system that certain combinations of words as entered by diary keepers could in likelihood add up to a code ("visiting friends" or "seeing friends" for example). This could then be a stepping stone for further automation and scaling up. Were machine learning adopted, it may even be possible to use some sort of multiple choice response for coders to verify diary keeper input (which of these codes best describes the activity "went to cinema"?) which when weighted against other coder's answers to the same question could refine the processing. This could then speed coding up enormously for journey purpose.

Recommendations for Beta research:

- Build and test a coder dashboard with input fields for coders to add or select codes
- Test a wider range of user journey data (especially from actual journeys) with coders to confirm data quality is high and the codes can be assigned
- Workshop/demonstrate the prototype early on to coders as their collaboration will be needed and they will be able to spot potential data inconsistencies
- Involve the coders in the discussion about cross-referencing diaries within households

Accessibility

The Gov.uk design system underpins development of the Digital Diary, which includes the mandated hidden explanations where required. However, there were a few instances where the recommendations did not fulfil the answer requirements for the NTS.

Numeric input

The Gov.uk design system suggests using `inputmode=numeric` for text inputs that are expecting numerical data, which helps mobile users by showing them a numeric keyboard for input. However, on iOS, this does not allow a decimal place. For numeric input which should allow a decimal place, we have used `inputmode=decimal`. We have logged an issue on the Gov.uk design system backlog to clarify guidance.

Time input

There is no approved time field in the design system but there is a discussion in the backlog. Based on GDS recommendations, we decided to stick with a 12 hour field with an am/pm dropdown. However, feedback from the majority of users of the Enhanced Digital Diary showed a marked preference/expectation for a 24 hour field, or at least acceptance of both formats.

Money input

Again, there is no specific recommendation for money input fields but a useful discussion logged on Github offered several successful design solutions, including one from HM Courts and Tribunal Service which we have implemented. There have been no errors logged or issues raised with users regarding this field. With respect to the `inputmode=decimal` mentioned above, HMCTS do not have any `inputmode` attributes on their currency input. We have an item in the backlog which will change to use `inputmode=decimal`. This will assist mobile users by showing them a numeric keyboard (including decimal place).

In spite of the social distancing rules in place at the time of testing, we had several users with registered disabilities and health conditions in our testing stable of 25, all in the New Participants group. These included:

- 1 individual with extremely low digital confidence
- 1 individual with autism, fibromyalgia and mobility issues
- 3 individuals with anxiety, depression or other mental health concerns
- 2 individuals with dyslexia

Our testing group also included 4 users over the age of 65 and 1 over the age of 70.

Note: The 6 previous NTS participants were not asked about additional needs.

Anxiety disorders

Two individuals who had agreed to test the Digital Diary dropped out after receiving the onboarding materials. In both cases, the individuals didn't respond for some days, and when we followed up, cited "having a lot going on" or "don't think I'll get round to it" as reasons for being unable to complete the diaries. In one case, the user had previously done user testing

but was trying to organise a house move at the same time. In the second instance however, the individual had mentioned in earlier conversations that they were bored at home and “trying to keep busy”. In this case, the reluctance to begin the diary may have stemmed from either the ‘testing’ nature of the request and concerns over their own abilities, or from the perceived complexity of the onboarding instructions. The addition of supplied test scenarios also added a significant amount of text to the instructions. Any worries over completing the diaries may also have been exacerbated by ongoing background anxiety from the global Covid-19 pandemic, which had just started. We think that the paper diary and interview process would have been more readily received by this person.

Autism

One individual who has an autism diagnosis as well as fibromyalgia had no issues using the Digital Diary, and understood how the diary worked and where to put the information. Where they did encounter difficulties was in breaking their journeys down into the component stages required for the NTS as they wanted to include every step, regardless of distance or location. While inputting a Walk, for example, having no destination and also having to leave out the part of the journey where they were walking in fields sufficiently confused them as to result in them abandoning the journey, even though they knew the information was not properly correct.

“...couldn't work it properly so I did 3 stages rather than a return... I couldn't see how to add 'Field' into a stage either.”

Rather than delete the journey however, they left it to be amended by their moderator/Interviewer. The rest of their diary was correctly and thoroughly filled in, so this was interesting to note. Two other participants also commented that leaving out pieces of information, rather than being a time-saver, was in fact disruptive to the thought process.

“It would be easier to just record everything and have you strip it out later than have to keep checking whether a journey qualifies.”

Depression

Our testing group included three individuals suffering from depression. Two of these users also had an anxiety disorder and both dropped out of testing prior to starting their diaries. The third user had no other reported health issues and successfully completed two rounds of testing, first with the basic Digital Diary and then the Enhanced Digital Diary, providing useful feedback at the end.

Dyslexia

Two individuals had dyslexia, both were digitally confident. The first user was under 18 years and completing the diary as part of a household. The second user was over 18 years and completing the diary as a single user. Both users had difficulty in various areas of the diary, where similar words were conflated (e.g. Return Journeys vs Repeat Journeys) or where instructions appeared to contradict what they expected to do next. In both instances, the individuals were assisted by validation errors to prompt them for the correct information.

A visually impaired persona is included with the persona group, but none of our testers declared themselves visually impaired. Further accessibility testing is needed to test our assumptions about this persona.

Conclusions

The Enhanced Digital Diary was very well received by previous NTS paper diary keepers, and they all noted that it was easier and quicker to fill in than the paper diary had been. For new NTS respondents (i.e. those who had never filled in a paper diary), while the Enhanced Digital Diary improved data quality and reduced some of the burden for diary keepers, they had higher expectations and felt that there were still improvements that could be made to make diary completion easier for participants and interviewers.

Common pain points still in the diary keeping process are:

- Journey stages
- Household sharing (i.e. one householder filling in multiple diaries)
- Ticket types
- Conversion of journeys into NTS components
- Public transport distances (i.e. knowing distance travelled via train)
- Self-anonymisation of travel data

When it comes to the paper diary, participants have the option of skipping fields that they find challenging, making partial recordings that can then be tidied up by the Interviewer. There is no option of doing this with the Digital Diary, which has the benefit of improving data quality but may also result in lower recording rates or increased dropout rates, as fatigue is likely to set in earlier. While we have allowed certain fields to be left blank by the user, the GDS principles for design and layout would make it difficult to streamline the survey process any further, but it is worth further user experience consideration to see if any additional shortcuts can be built in.

Key to the success of the NTS is the role of the Interviewers. While data quality in the completed Digital Diaries was better than that in the paper diaries, when digital users were onboarded in person (via phone or person visit) rather than via email, data quality within the Digital Diaries was better, and there was an increased willingness to record journeys. Even then, each diary required follow up with a member of the project team to check the data and query anomalies, and it should be noted that only 3 out of 10 new user testers who were onboarded via email had no anomalies in their recorded journey data.

Recommendations Summary:

- Progress to Beta to continue development of the web-based diary and increase the testing sample
- Arrange accessibility testing and engage an accessibility expert to review the prototype early on in the Beta stage
- Further accessibility input needed in terms of instructions and button labels, particularly around similar looking words and dyslexia (e.g. repeat/return confusion)
- Further testing with users who score low on the Digital Inclusion Scale to make the diary more accessible to people with low digital confidence

- Identify and arrange testers with visual impairment to test assumptions in regards to screen readers and other assistive technologies
- Collaborate with NatCen to fully test the data journey; the connection, data-pull and subsequent blending with the paper diary data. This will involve some development from NatCen
- Design and develop method of authentication within Firebase that allows designated diary keepers to fill in other household members diaries if required and ensures a child's account/profile doesn't necessarily require a separate email address to onboard
- Further enhancements to explore:
 - Digital 'practice day' functionality
 - Improved messaging to support journey stages and modes of transport
 - A/B testing with validation errors of data input fields to inform user experience
 - Household journey sharing/copying/tagging functionality
 - Household dashboard for group diary management
 - Use of mapping software to allow users to plot journeys and to auto-validate journey distance
 - Prompt/help system to assist with diary completion

Browser-based Geolocation

In order to establish whether geolocation services within a web browser could be used for a phone-based web version of the NTS, we first had to establish accuracy. These solutions often work by looking at the user's IP address and mapping that to the position of the telecommunications hub or cell phone tower that is nearest to the user. We discovered that the accuracy of the browser's ability to locate the user was wildly variable and in many cases resulted in location data that was far out, ranging from 3 miles to over 40 miles for a non-proxy service user (e.g. locating a device from Trowbridge, Wiltshire at Weston-Super-Mare, Somerset, some 40 miles away). In both instances, this was in no way accurate enough to utilise for the NTS and if the user was on VPN or some other proxy service, the 'identified' location was even further away.

To a lesser extent, this would also have a bearing on whether maps could be presented within the browser-based version to allow people to drop a pin on their location. The map would need to be pre-zoomed in on the user's approximate location before they were able to drop a pin, and therefore location in the first instance would need to be fairly accurate.

Conclusions

The conclusion was that browser-based geolocation services were too inaccurate to be of use for the NTS.

NTS Smartphone App

While unable to develop and test a native app as part of this Alpha, we did keep a log of all app references during user testing, and also asked users post-diary completion how they would feel about an app.

During the testing process, there was notable preference for an app among the male participants in particular, with several suggesting it unprompted (without being asked). Post-diary completion, every user was then asked one or two questions about app preference:

1. If there was an app that could gather the time you set off and arrived, the distance you travelled and the time you spent travelling and uploaded it automatically via the tracking functions on your phone, would that be preferable to you?

When talking to people over the phone or via message, some users answered the first question and immediately included details about their security concerns without being asked. For those that did not, or who were being surveyed by email, we included a follow up question:

2. What, if any, concerns would you have over privacy or security if the app was tracking your movements for a week?

Security and privacy concerns are the most commonly cited reason for users not downloading apps/using programs that have any form of data sharing or tracking capability, so it is important to show consideration of these issues.

Key Surveying Outcomes

There was a clear gender split within our testing group in regards to app preference, with 5 out of 11 male participants expressing an unprompted preference for downloading an app:

"I'm pretty paranoid about most things but I would much prefer an app that could do most of it for me."

A further 4 out of the remaining 6 male participants expressed a preference for an app when asked.

"This I would use and would love for the app to prompt you to fill out your travel diary."

0 of our 12 female participants mentioned an app without being asked.

When asked, 7 out of 12 female participants expressed a preference for an app, with 5 out of 12 saying they would not use an app.

"I wouldn't trust an app, well, not the app, I mean I don't like the thought of my travel information sitting somewhere. You don't know who's looking at it and who can get hold of it. One of my friends uses Strava to record her dog walks, but it's telling people where she goes every day and at what time, and where her house is. Even if you don't make that public it's still sitting there somewhere."

1 participant, when asked, already used expense-tracking and activity-tracking apps, and so had no preference for a specific NTS app, but noted that:

"[I think] anyone capable of filling this in will have ready access to that kind of info anyway? Might improve accuracy where guesswork is a factor."

6 out of 25 surveyed participants mentioned privacy as a concern, although not necessarily a barrier, when asked about using an app for the survey.

Although mentioned as a concern in the Discovery report, none of our participants mentioned battery life as a potential issue. However, one user did mention their data plan, and this would be a particular consideration for children and young adults who are more likely to be on PAYG plans.

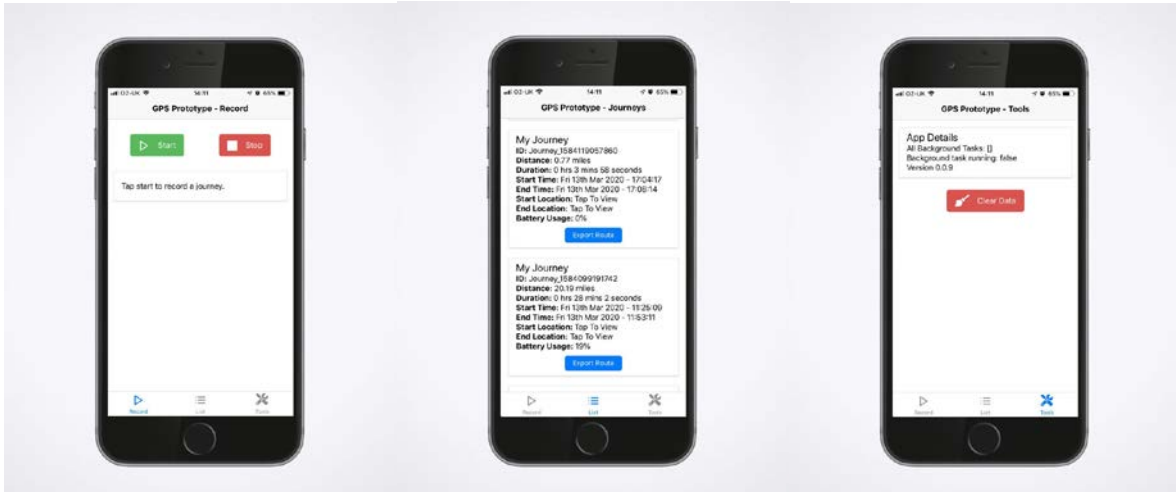
Note: If these findings are true of the general population and the NTS were to move to an app-only collection method (rather than offering it as an option), then the differences between men and women in terms of security concerns could see a reduction in the number of women agreeing to participate in the diary-keeping process. Given the evidence supplied by the Interviewers that women in a household are more likely to fill in the diaries (and often for everyone), this could result in a significant drop in completion rates and data quality for the NTS diaries.

GPS Journey Tracker Companion App (level 1 app)

Based on our developed prototype, we were able to record sufficiently accurate journey data to help participants record their journeys. Our project team testers were able to use the data to help populate their Digital Diaries with key information, i.e. journey distance and journey time. This could be a useful addition to the suite of tools offered by the NTS to help diary keepers complete their diaries, and could be used as well as or in place of the current memory jogger.

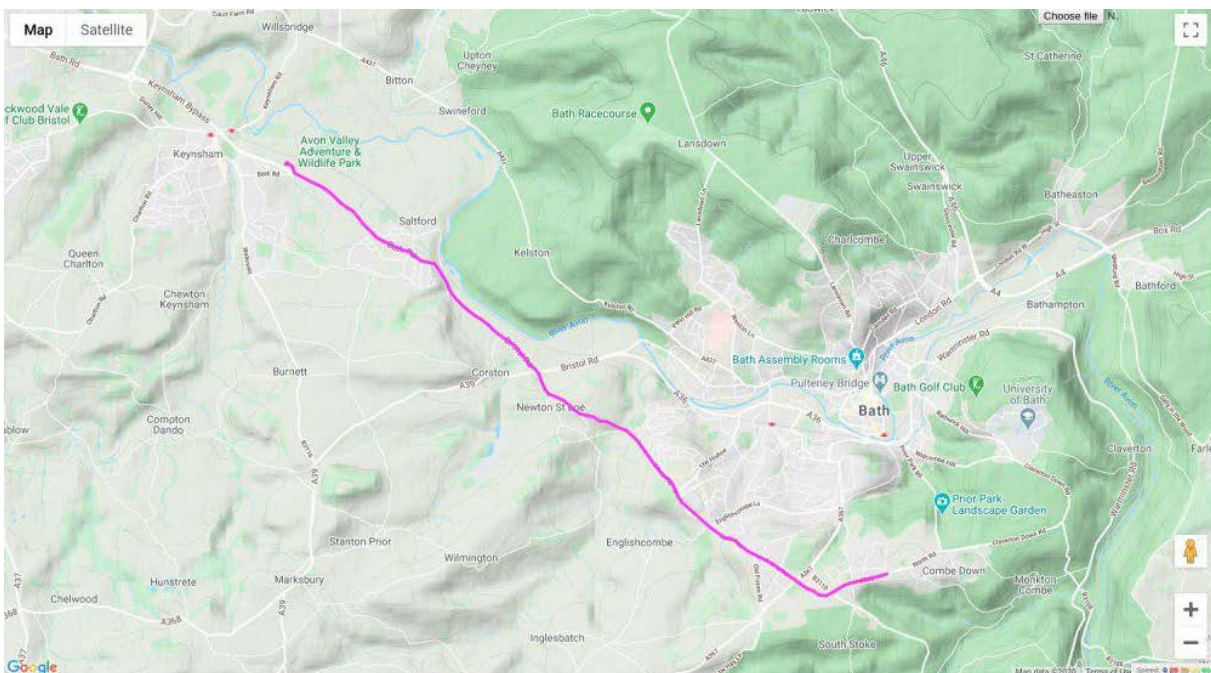
The app used a simple Stop/Start button format to ensure no tracking took place without active permission each time, and our three project team testers were able to clear the journey data from the app at any time.

At no point was data transmitted or shared beyond the individual's device.



(Above: Three screenshots from the device mocked up into an iPhone6 to show context)

In order to test the accuracy of the GPS data being captured on the phone, we temporarily stored the marker points in a way that we could export into mapping software. The results showed we were capturing the correct route and therefore collecting the distance to an accurate enough degree for the purposes of the NTS.



(Above: The data from a an internal test journey plotted onto a map)

We submitted a DPIA for the Level 1 app to the Data Protection Assurance team and also to the Architecture Change Board.

GPS Native NTS App

There are three main barriers that we see for a complete NTS native app.

The first barrier is **internal**, and concerns the GDS recommendations around **use of native apps** for data collection and the GDS and DfT principles surrounding collection of necessary personal data.

To successfully complete the travel diary using an app, the user would need to consent to have their location and travel times tracked for the length of the survey (7 days). This would inevitably record sensitive personal data, such as:

- Location of family schools
- Location of participant's GP practice
- Types of medical practice visited (e.g. counsellor's office, sexual health clinic)

This particular barrier could be overcome by holding the data on the participant's smartphone and 'cleansing' it before it was submitted to the DfT. This would require the data collected to be held solely on the participant's device, populating the diary with only the necessary information, such as distance, time, anonymised location descriptors (e.g. Medical). Only the anonymised diary information would be submitted with the completed diary, and the participant would then be prompted to 'Clear Data' from the app, and then delete the app entirely from their device.

The second barrier is **external** and concerns participant **technology** and **service quality** in a participant's location. As of 2019, 79% of all adults in the UK own a smartphone, but that is not the same across all age groups. The number goes down to 73% for 55-64 year olds, while just 40% of those over 65 years own a smartphone⁸. Users without smartphones or using older devices might not be able to make use of the app, which would need to be updated regularly on both iOS and Android stores in line with new device and OS releases. Likewise, users in remote rural areas may find that the network services are erratic, or that markers are not reliably or accurately placed. 72% of mobile connections across the UK use 4G, up 6% from 2018. Use of a native app is already likely to be filtered by age, and this would have the potential to further filter participants by device and location.

Unfortunately, due to the coronavirus pandemic and subsequent travel restrictions, we were unable to test this in the field but previous research within the DfT showed that GPS accuracy is good enough for NTS purposes⁹. Quality of service and technology will also improve for all age groups over time however, and within 10 years, the numbers of people without either a smartphone or good reception should be increasingly small.

The third main barrier is also **external** and concerns **survey format and participant expectation**.

While testing the Digital Diaries, we discovered that simply by putting the NTS online, participants expected a certain level of auto-population to occur. Frequent use of internet

⁸ <https://www.finder.com/uk/mobile-internet-statistics> - sources: 5GUK Limited, Office for National Statistics, Ofcom, Android Central, Tutela Annual Report

⁹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641452/modernising-the-national-travel-survey.pdf

map tools in day to day life meant that a number of our testers expected to be able to use postcodes for start/end points and have journey distance automatically calculated. Others expected return journeys to be added by default. For some of our user testers, this had a major effect on their willingness to complete the diaries, as they felt that,

“It should have been easier.”

It's useful to note that while those who had previously kept a paper diary felt the online version to be far easier and quicker to complete, this feeling of difficulty was common among new participants who had never filled in the paper diary. The NTS questionnaire and the information that's required mean that it is currently not possible to auto-populate all the fields using data gathered via GPS, and those that could be auto-filled would still require action from the participant to confirm that the guess was correct. As NTS respondents would be new participants, the expectations towards ease-of-use are likely to be higher with a native app and therefore the manual intervention potentially perceived as more burdensome.

It would be possible to increase auto-population options by making use of third party mapping APIs to identify roads, bus routes and train lines, and overlaying a user's journey to 'guess' at transport modes and journey stages. The user would still be required to confirm certain factors (e.g. own car/friend's car/taxi/bus), ticket type/cost, and household travelling companions, but it would reduce the number of interventions significantly.

Finally, while not a barrier, it should be noted that many people have serious privacy concerns regarding location-tracking smartphone apps and so may decline this option. It would also be more difficult for one householder to complete diaries on behalf of other household members when using GPS. In the 2011 pilot they saw a 7% drop in uptake by households being offered the GPS device when compared with the offer of a paper diary.¹⁰ For this reason, we recommend that any future app version of the NTS be presented as one of three options for participants, alongside the paper diary and the Digital Diary, although this would need careful consideration within the DfT due to the cost, complexity and potential data differences caused by using three different collection methods.

Conclusions

There are pain points built into the fabric of the NTS questions and not all of these can be solved using technology. While a native, GPS-tracking app could more accurately measure travel time and distance, and - with enough partnered APIs and mapping data (i.e. road maps, bus routes, train lines, tube maps, cycle routes) - could potentially make good guesses at modes of transport and journey stages, but would still require manual confirmation from the participant to submit accurate data.

An example of this would be knowing the difference between a Diary Keeper driving their own car, being a passenger in a friend's car, riding in a taxi or being stuck in traffic behind a bus. The app would have to make a suggestion and have the Diary Keeper confirm or edit the guess. The risk is that the further into the diary period a participant is, the less likely they

¹⁰ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230561/NTS_2011_GPS_Pilot_Field_Report.pdf - page 12

may be to either notice mistakes or take the time to edit the guesses, preferring to accept a guessed journey (and submit inaccurate information) than to correct it.

Ticket types and cost would be very difficult to do automatically, as it would require access to a Diary Keeper's ticket purchasing app or similar. A bus pass holder wouldn't have this.

It's also important to remember that the survey is 'per household'. The Discovery research and Interviewer feedback shows that one member of a household often fills in diaries for the other members (including other adults). Use of a smartphone app would require other adults in the household to be responsible for verifying and editing their own diaries, and for the main diary keeper to still have to use a secondary method to record journeys for household members who could or would not use the app, particularly young children. A recent survey found that phone ownership doubled in children between the ages of 9 and 10 years old, finding that 50% of children aged 10 years old had a smartphone.¹¹

Recommendations:

- Create a new and separate Alpha project for the development of a prototype NTS native app to explore the extent to which the NTS questionnaire can be completed using GPS functionality, but do this once the Beta for the MVP is completed
- Review the existing NTS with a view to seeing the questionnaire translated into a smartphone app
- DfT to decide on an NTS roadmap regarding any additional data to be collected, the best collection methods for that data, and sample size goals, which can be achieved in a second Alpha for an NTS native app and the Beta for the Digital Diary
- Further test and discover what level of human (Diary Keeper) intervention would be required to turn GPS-collected travel data into the information required by the survey

¹¹ <https://www.bbc.co.uk/news/technology-51358192> - Feb 2020

Beta Recommendations for the National Travel Survey Digital Diary

Many of the issues relating to diary completion come from the difficulties in translating whole journey information into the component parts required by the NTS.

Requested features for Beta are:

- Sharing journeys - tagging of other householders in a journey to populate multiple diaries simultaneously
- Household diary access - allowing one person within a household access to other members' journeys to allow them to add journeys on behalf of others, especially children
- GPS functionality - e.g. 'Where am I?' and user-centered mapping
- Pick start/end points on map - allowing a user to drop pins of their start and end locations to auto-fill in time and distance travelled
- Automatic distance validation - using maps to fill in journey distance
- Automatic time population - using start/end times to fill in journey duration
- Participant - interviewer help system

Support in Beta

The NTS requires a certain amount of self-editing, not just for qualifying data (e.g. walking distances) but also to partially anonymise data for submission (e.g. replacing address with a label), converting round trips into journeys, and times/distances into minutes/miles, etc. The majority of mistakes our testing group made were not to do with using the diary but in the conversion of actual data into NTS data. To this end, support will continue to be required with the Digital Diary just as with the paper diaries.

Due to the coronavirus lockdown, the importance of in-person onboarding to help with this conversion rapidly became very evident. Users who were onboarded in person by the project team (prior to lockdown) completed their diaries more accurately and with less perceived burden than those that were onboarded post-lockdown via phone and email.

Although documentation was provided for all participants, only 3 of our 17 active New Diary Keepers said that they had read it in its entirety. 4 out of 6 New Diary Keepers who were onboarded in person completed their diaries to a good standard, compared to 4 of the remaining 11 New Diary Keepers who were onboarded remotely completed their diaries without error.

We recommended developing improved online support for completing the diaries, as well as improving prompts and guidance messaging to assist users in the conversion process. The recommendations include:

- Provision of intuitive online documentation

- Video onboarding hosted with the diary to help Diary Keepers onboard themselves
- Interviewers should be first line - they have a rapport with the Diary Keepers, and intimate knowledge of their travel habits due to the survey they do in advance
- Interviewer- Diary Keeper messaging system, to allow Interviewers to send prompts to Diary Keepers regarding mistakes and for Diary Keepers to ask for help if required. This might become less necessary for identifying problems as the automated notifications are further developed to identify problems, although might still be helpful for the Diary Keepers to contact their Interviewer
- Centralised technical support should form a second line
- Training knowledge for interviewers should be documented as well as being portable and transferrable to allow for changes in supplier or staff
- Training needs should be assessed and planned with NatCen (as current providers) and will involve early collaboration with NatCen stakeholders, but also the NatCen operations team and regional managers.
- Many of the interviewers work on different surveys so their time doesn't exclusively belong to the NTS and the cost of skills transfer, and any collaboration will need to be factored into the cost for Beta
- This would also provide a strong, tested and refined support base ready for potential native app integration into the service

KPIs for Beta

As identified in the Discovery report, the early evaluation plan included the following KPIs:

1. **Increase diary completion rates among agreed participants** - In 2018, 90% of those households who participated in the NTS interview completed travel diaries for all household members with a 10% abandonment rate.
2. **Increase participation rates in underrepresented demographics e.g. young men** - A useful measure would be an increase in the number of underrepresented demographics agreeing to keep a diary when given the digital option. Representation of other demographics also needs to be maintained.
3. **Increasing journey recording rates for days 6 and 7** - There is a marked decrease in journeys recorded on days 6 and 7 as fatigue sets in, and as such, data for those days is more heavily weighted in the output. Increasing data for those days would be a marked improvement.
4. **Cost per transaction** - Current cost per transaction is estimated to be approx. £48.25 per completed diary. Recommendation is to keep the Interviewer role and existing onboarding process, so cost per transaction will be influenced by the increase or decrease in diary completion rates. Note that calculating an accurate cost per diary is problematic. This is because interviewing, data management, logistics and data processing tasks for the diary and interview are entwined. Further, there are economies of scale when it comes to processing diary data, both overall and within household. However, this serves as a best current estimate based on a series of assumptions applied to actual survey delivery costs.
5. **Diary Keeper satisfaction rates** - The number of digital participants reporting their interaction as satisfied or very satisfied.
6. **Reduce time for pick up interviews** - Interviewers do their best to keep the exit interview short, but where data is incomplete or incorrect, they have to do what they

can to complete the diaries with the household to ensure they get their reward voucher. This information is anecdotal and varies by demographic, but when asked, Interviewers suggested that an exit interview of 30 minutes was a good result.

Beta Team Requirements:

- Product owner/manager (DfT)
- Delivery manager (Technical partner/Contractor) - To manage the agile environment, prioritise sprints, monitor progress and keep the project on track
- Technical lead (Technical partner/Contractor)
- 2-3 x Full Stack Developers (Technical partner/Contractor) - One of whom should specifically be designated as coordinating digital assistance development
- Content/Copy editor (Technical partner/Contractor) - To refine the onscreen text
- UX lead (Technical partner/Contractor)
- User researcher (Technical partner/Contractor)
- Accessibility lead (Technical partner/Contractor)
- Business analyst (DfT/Technical partner/Contractor) - There are numerous workflow, skills and cost changes involved in taking the project onto Beta and these need to be fully explored, costed and managed. This would be best served by appointing a partner from the DfT who has knowledge of department business processes
- Architect (DfT) - The team will need a sponsoring architect to advise on architecture compliance and present material to the Architecture Change Board

In addition, the team will need to draw on the following resources/teams:

- NatCen technical team (for collaboration on the data transfer/collection)
- NatCen Operations team/Regional managers - to work with Interviewers
- DfT Architecture team (including the Architecture Change Board)
- DfT Data Assurance team
- DfT Security team
- DfT Digital team - Platform provision and support
- DVLA testing lab in Swansea - Initial enquiries confirmed that as this is a DfT project no cost would be incurred in using the labs (but testers themselves will need incentive/expenses). The DVLA team also has access to large base of A/B test subjects

Note for Beta project team: The DfT Architecture Change Board meet every two weeks on a Wednesday, with documentation needing to be supplied to the sponsoring architect on the Wednesday/Thursday a week ahead of the meeting. On commencement of the Beta phase, we recommend factoring in ACB meetings to the timeline as the solution may require more than one submission.

Appendices

Appendix 1: Validation Error Log Summary

Stage Details: "Including you, enter the number of people that travelled with you" - left blank (1 individual, 1 error)

Stage Details: "Enter the number of people who travelled with you" - left blank (7 individuals, 8 errors)

Stage Details: "Enter the time you spent travelling in minutes" - left blank (4 individuals, 4 errors)

Stage Details: "Enter a real travel time in minutes" - 8hours/5minutes/1.10 (3 individuals, 3 errors)

Stage Details: "Enter the distance you travelled" - left blank (5 individuals, 6 errors)

Stage Details: "Enter a real distance (e.g. 1.25 or 12)" - 4,400 / 0.2 (2 individual, 8 errors)

Stage Details: "Choose whether your distance is in metres or miles" - left blank (8 individuals, 12 errors)

Stage Details: "Enter a real number of adults" - '-' (1 individuals, 1 error)

Locations: "Select where your journey ended" - left blank (15 individuals, 25 errors)

Locations: Other start point: "Enter a location" - left blank (1 individual, 1 error)

Locations: Other end point: "Enter a location" - left blank (2 individuals, 3 errors)

Journey Purpose: "Select the purpose of your journey" - left blank (8 individuals, 26 errors)

Journey Purpose: Other purpose: "Enter the purpose of your journey" - left blank (2 individuals, 2 errors)

Journey End Time: "Enter the time you arrived" - left blank (5 individuals, 9 errors)

Journey End Time: "Enter a real hour value (1-12)" - 24 hr clock usage (5 individuals, 7 errors)

Journey End Time: "Select am or pm" - left blank (1 individual, 2 errors)

Journey Start Time: "Enter the time you departed" - left blank (2 individual, 2 errors)

Journey Start Time: "Enter a real hour value (1-12)" - 24 hr clock usage (14 individuals, 21 errors)

Journey Start Time: "Enter a minutes value (0-59)" - left blank (5 individuals, 5 errors)

Journey Start Time: "Select am or pm" - left blank (5 individual, 7 errors)

Journey Method: "Select the method of travel you used for this journey" - left blank (6 individuals, 10 errors)

Journey Method: Other: "Enter details about the method of travel you used" - left blank (2 individuals, 2 errors)

Journey Method: Other Vehicle: "Please specify the vehicle you used" - left blank (3 individuals, 4 errors)

Driver & Parking Cost: "Select whether you were the driver or passenger" - left blank (1 individual, 1 error)

Driver & Parking Cost: Parking Cost: "Please enter a real cost e.g. £3.70" - 5.1 and 4.4 and 0 and 0.0 (2 individual, 3 errors)

Boarding Count & Ticket Cost: "Enter the number of times you boarded" - left blank (3 individuals, 4 errors)

Boarding Count & Ticket Cost: Ticket Cost: "Please enter a real cost e.g. £3.70" - 5,000 and 29.1 and 80p (3 individuals, 3 errors)

Boarding Count & Ticket Cost: Ticket Type: "Choose the type of ticket you used" - left blank (4 individuals, 5 errors)

Boarding Count & Ticket Cost: Ticket Type: Other: "Tell us about the ticket you used" - left blank (2 individuals, 2 errors)

Day: Diary Day: "Please select a day with journeys (1 individual, 1 error)

Appendix 2: Backlog

Major Features

- Create a coder dashboard (similar to the Interviewers' full-week view) to enable NatCen coders to code the diaries
- Investigate and implement a mechanism for NatCen to pull the coded data. One option might be to replicate the database to a private replica. Completed diaries could be deleted from the public database, but kept indefinitely on the private replica. NatCen could be given read-only access to the private copy to pull the data at their convenience.
- Add prompt/help system to allow users to self-guide.
- Add messaging functionality to allow Diary Keepers to receive guidance from Interviewers.

Minor functionality and UI/UX enhancements

- Migrate password reset into the site to alleviate user confusion (When using the Firebase password reset, some users with Gmail accounts were confused into thinking that it would reset their email password).
- Look into Firebase ID tokens duration (currently only 1 hour). This may be due to the use of an incorrect API endpoint.
 - Add in functionality to automatically use Refresh tokens to fetch new ID Tokens upon expiry.
 - The "Sign in with email / password" endpoint seemed to - from basic testing - provide 2 week ID tokens. (<https://firebase.google.com/docs/reference/rest/auth#section-sign-in-email-password>)
- Offline mode:
 - Could be extended to include Journey Stage wizard.
 - Window history is updated, but external changes (e.g. back button) are not handled.
- Add more notifications to the system to further improve the quality of data obtained.
- Ability to edit a dependent's diary (i.e. Ability for a single Diary Keeper to be given ability to edit multiple diaries within a household).
- Journey sharing functionality (e.g. "Bob accompanied me on this journey" causing a mirror journey to appear in his diary)
- Advise users earlier about recording walks on days 1 / 2-7
- If a Diary Keeper is unaccompanied and using private transport - pre-fill as driver (do not hide option)
- Return and repeat journeys should not pre-fill start/end times, or stage durations as copying times/durations encourages blind duplication without considering variations

Performance

- Improve GCP performance - initial aspects to look at are a custom docker runtime for AppEngine (<https://cloud.google.com/appengine/docs/flexible/custom-runtimes/build>),

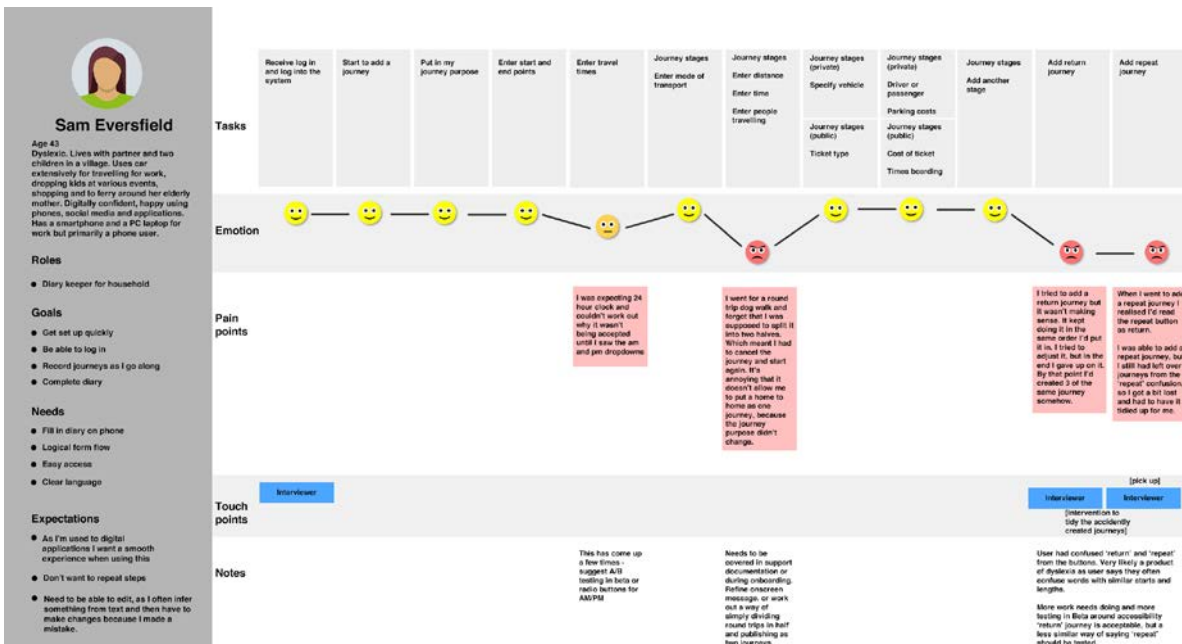
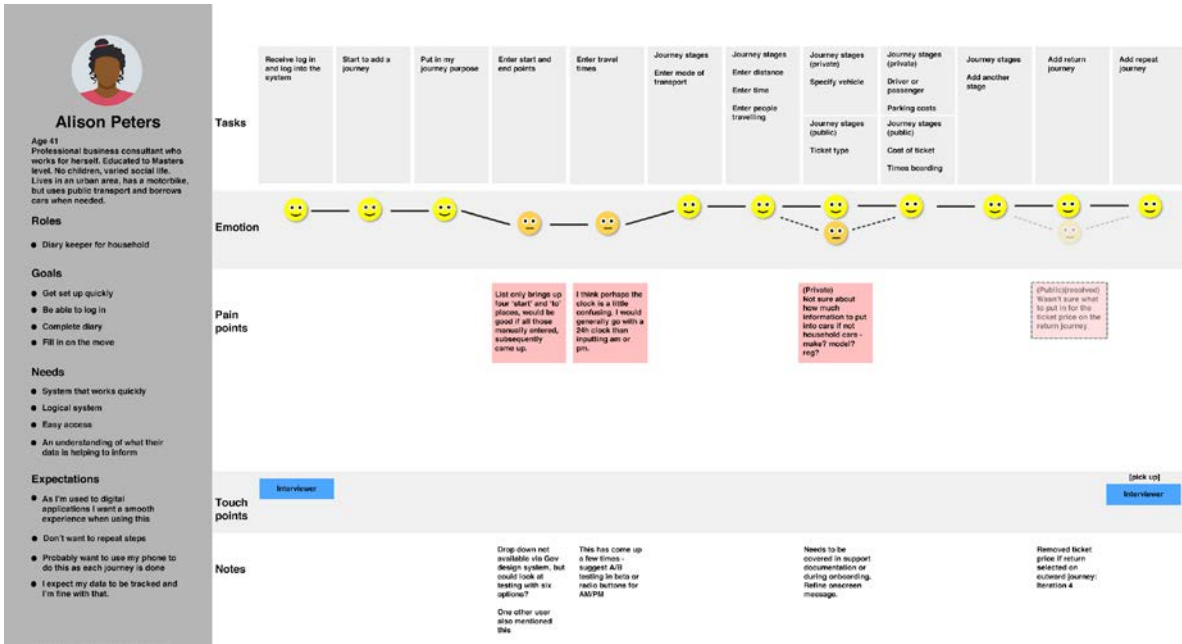
to improve Symfony's caching, or falling back to using memystore.
(<https://cloud.google.com/appengine/docs/standard/php7/using-memystore>)

- Look to improve the underlying performance of the API platform.
 - Repository methods for improving SQL efficiency.
 - Making sure caching is correctly configured (e.g. for serialisation).

Testing

- Add analytics and employ testing (A/B and/or multivariate) to inform decision making.
- Add a fully-fledged feedback page.
- (Possibly) implement a survey to garner feedback from users after they have completed (or abandoned) the survey.

Appendix 3: All User Journeys



Owain Emson
 Age 17. School child at one of A Levels. Gamer, with a part time job that he walks to after school.
 Lives in a rural town near a large city. Owner of a rescue dog that needs to be driven to a safe and quiet place to walk.
 Walks to school. Travels by car and train for social/family life. Very busy social life.

Roles

- Diary keeper as part of household

Goals

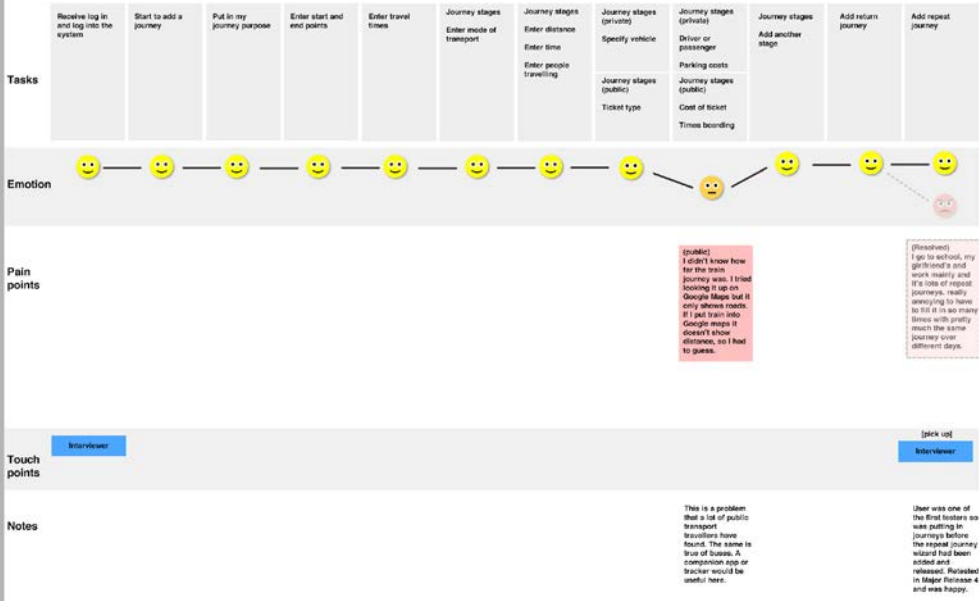
- Be able to log in via phone and PC
- Record journeys as I go along
- Complete diary
- Accurately capture the variety of my journeys

Needs

- Clear readable pages
- Many of my journeys are the same so I need to be able to repeat them
- Fast performance

Expectations

- As I'm used to digital applications I want a smooth experience when using this
- I want it to be fast
- Want to switch between devices on the same account, desktop PC and phone



Anthony Walsh
 Age 48
 Lives with partner. Children grown and left. Runs village post office. Lives in a rural village. Doesn't use public transport. Not very active. Drives everywhere.
 Digitally very confident, happy using phones, social media and applications. Has a smartphone, an iPad and a PC laptop. Prefers larger devices.

Roles

- Diary keeper
- Likely to defer to partner keeping diary for him if an option

Goals

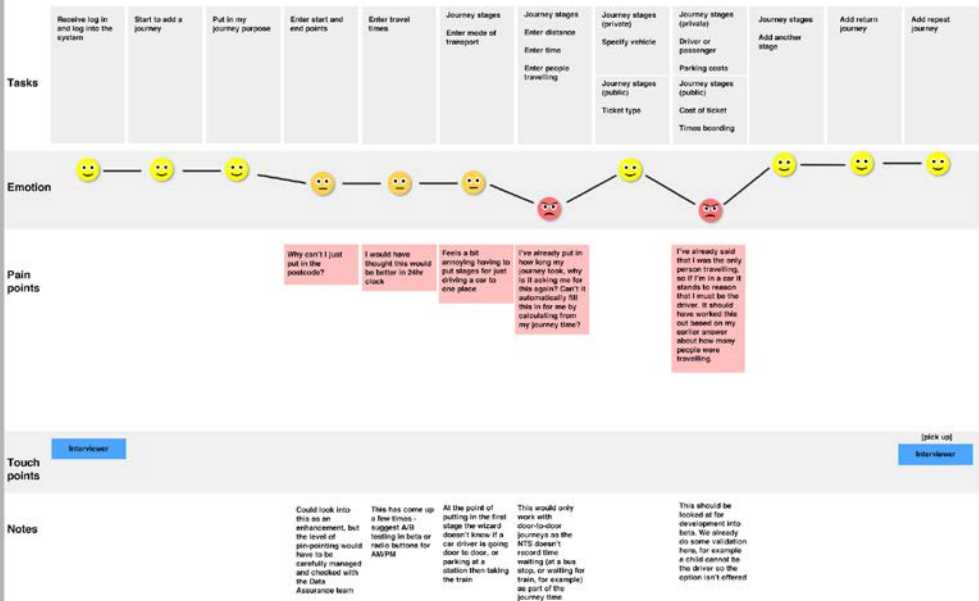
- Fill in diary easily, preferably using data collected on phone
- Do as little as possible, as quickly as possible
- Complete diary

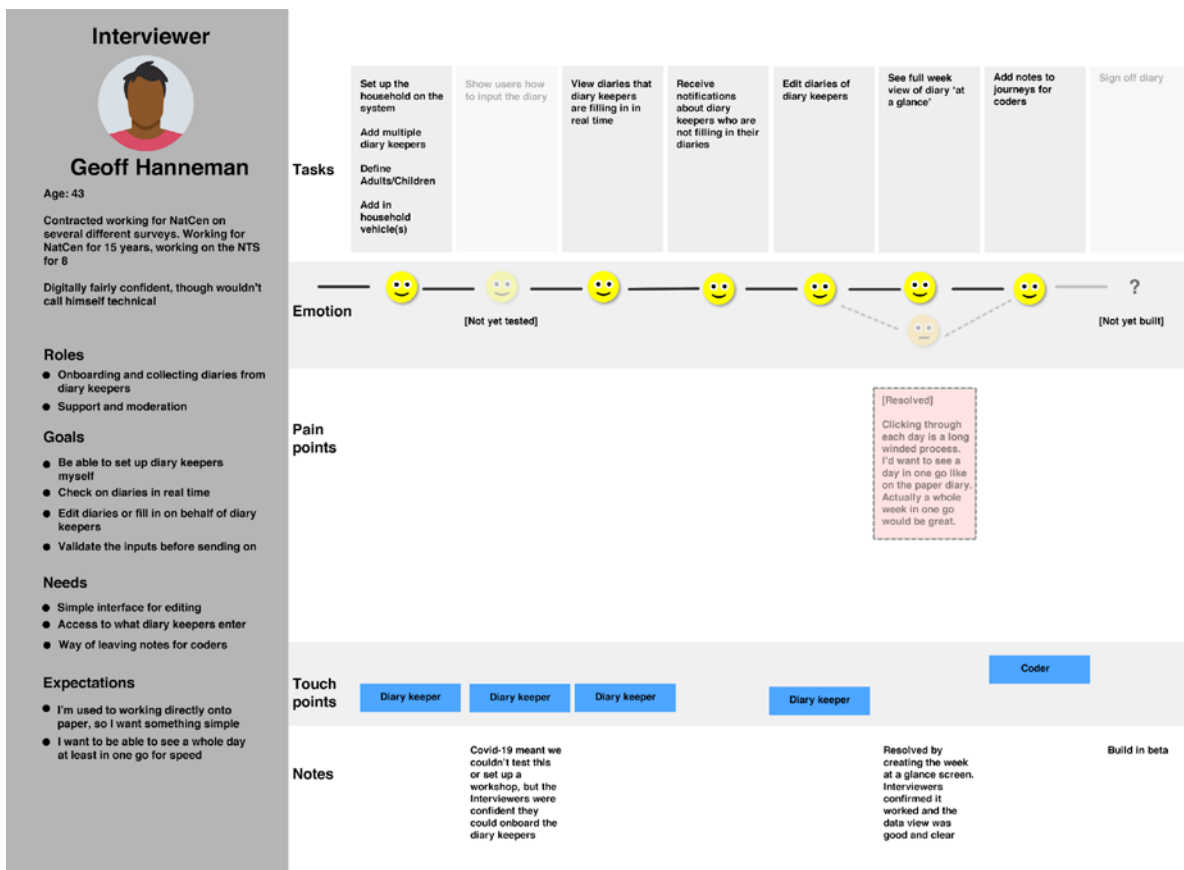
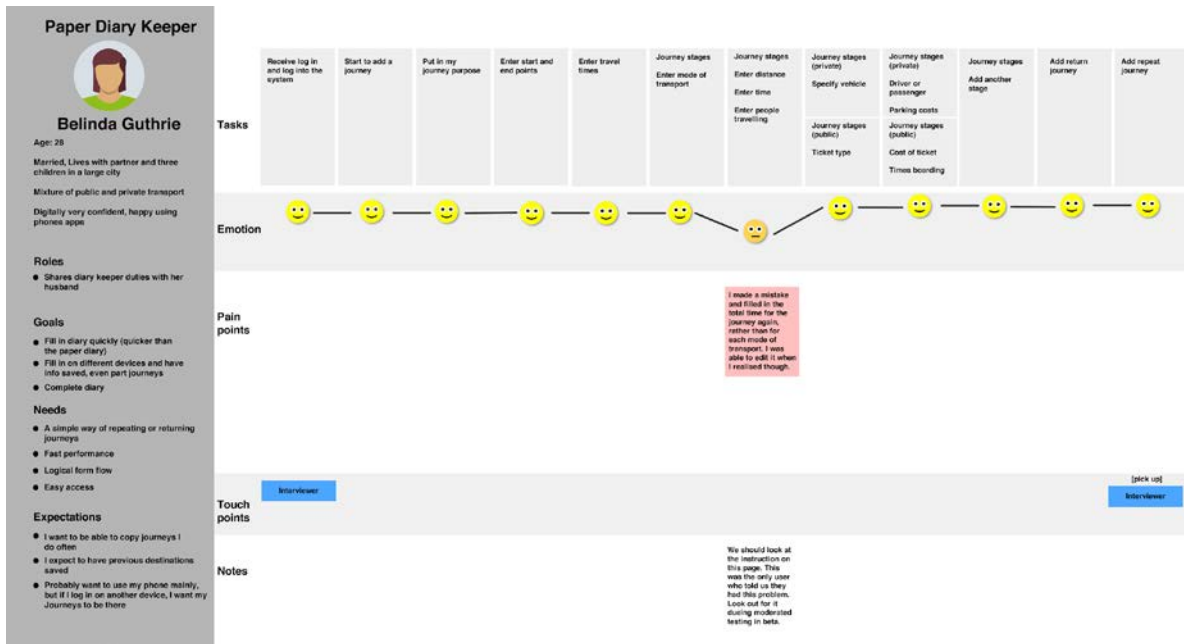
Needs

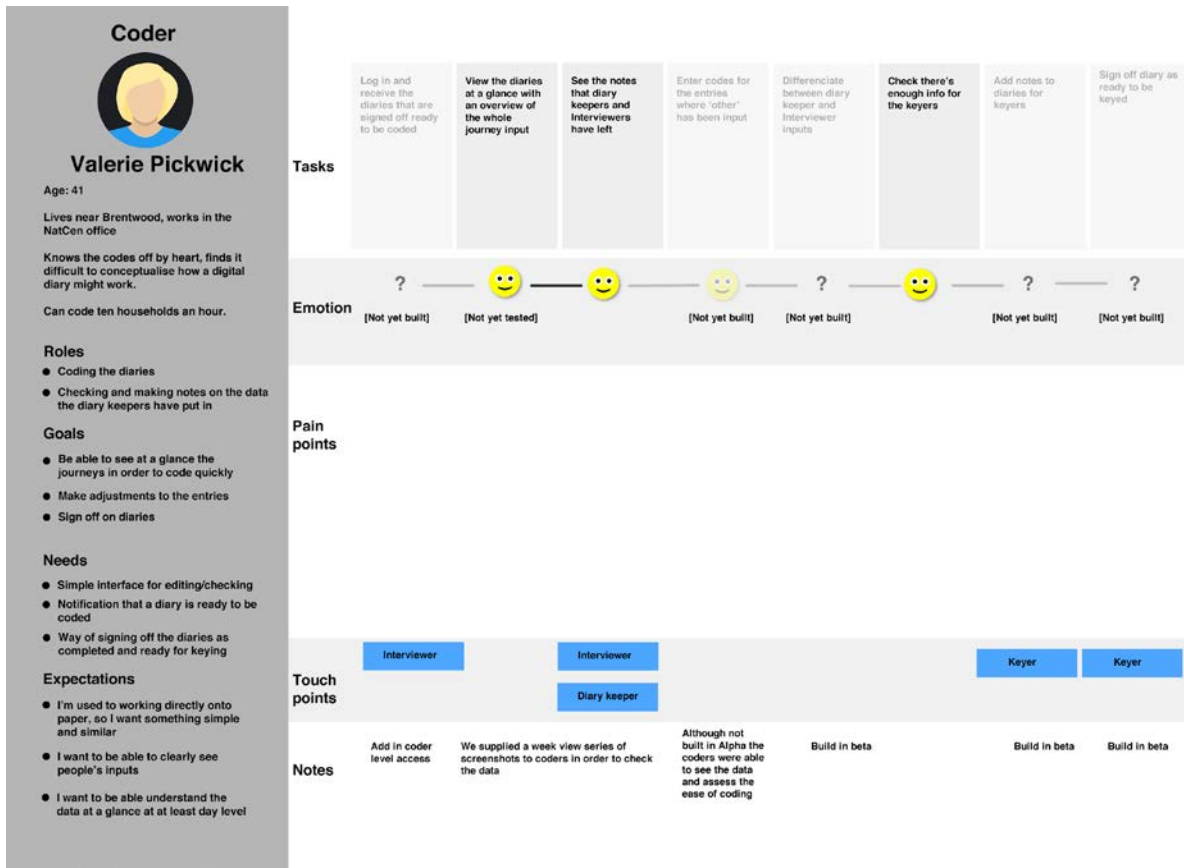
- Auto-filling wherever I think it should be possible
- As streamlined as possible
- Logical form flow
- Easy access

Expectations


- I don't expect this to take very long
- Don't want to repeat steps
- Probably want to use my phone to do this every evening after the fact
- Expect phone to collect data for me and auto-fill most fields








Appendix 4: All User Personas

<p>Diary Keeper: Child</p>  <p>Timothy Jones</p> <p>Age: 15</p> <p>Gamer, School student, Dyslexic Lives with his mother and older brother. In middle of GCSEs.</p> <p>Lives in a city.</p> <p>Walks to school. Travels by car and train for social/family life.</p> <p>Has difficulty with reading and spelling and receives support in school for this.</p> <p>Roles</p> <ul style="list-style-type: none"> ● Diary keeper as part of household 	<p>Goals</p> <ul style="list-style-type: none"> ● Fill in full week ● Probably complete as I go along ● Get the voucher for filling it in ● Encourage rest of family so he can get the voucher <p>Needs</p> <ul style="list-style-type: none"> ● Clear, readable and simple language ● No repetition ● Short bursts of text ● Want to switch between phone and PC <p>Expectations</p> <ul style="list-style-type: none"> ● Quick and not boring ● No complex instructions ● Some sort of automation, even if that's just the ability to copy previous journeys or select from 'favourite' places 	<p>Pain points</p> <ul style="list-style-type: none"> ● Unclear instructions ● Lots of text ● Long and boring processes ● Having to repeat the same steps over and over <p>Notes</p> <p>Diary keeper is highly motivated by the voucher.</p> <p>Is dyslexic which slows down his assimilation of the page and the instructions. Long pages would be painful to him as he doesn't read by inferring from context. Words that look similar could also cause confusion.</p> <p>An enhancement that would greatly help would be linking the diaries within a household so that if he was on a journey that had already been input by someone else, his diary could be filled in with the same details.</p>
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<p>Diary Keeper</p>  <p>Patricia Edwards</p> <p>Age: 72</p> <p>Retired teacher, church volunteer, not digitally confident (Reluctantly online) Widow with 2 grown children, 4 grandchildren. Lives on her own.</p> <p>Lives in a rural village. Mixture of car, lifts and public transport.</p> <p>Her daughter set her up with an iPad and she enjoys using iMessage. Distrustful of e-commerce and won't buy anything online, suspicious of downloads in emails and will ring her children if she's worried about security.</p> <p>Roles</p> <ul style="list-style-type: none"> ● Sole diary keeper 	<p>Goals</p> <ul style="list-style-type: none"> ● Fill in diary without anxiety ● Log in securely and with confidence ● Understand instructions ● Complete diary <p>Needs</p> <ul style="list-style-type: none"> ● System that feels secure ● Clear instruction from a trustworthy source ● Know where to find help/guidance ● When being led through a process, I need to know when it's complete <p>Expectations</p> <ul style="list-style-type: none"> ● As I'm not confident, I need to feel I can understand the process ● Simple logic and language ● I expect my data to be handled safely ● I want someone I can talk to if I get stuck 	<p>Pain points</p> <ul style="list-style-type: none"> ● Any technical language ● Unclear instructions ● Not knowing if something's worked ● Being left without support to fill it in <p>Notes</p> <p>Although this user has an iPad and (old) desktop PC, they rarely browse the web, except from links they're sent via email. Email is mainly used for family or church business. The iPad is used for taking photos and communicating with her daughter via iMessage. Wouldn't use any social apps or messaging services.</p> <p>In testing this user was set up via a moderated phone call, and the use of Facetime on an iPad. They were able to fill in some journeys while being watched, and when left to their own devices, very carefully followed the instructions and filled out all of the supplied scenarios with no mistakes.</p>
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Diary Keeper



Carl Schulke

Age: 24

Gamer, Not long moved out of home after completing degree.

Lives in a large town in the East Midlands with his girlfriend.

Uses a lot of public transport, but does have his own car.

Travels for social reasons and to get into work and back.

Digitally very confident.

Roles

- Diary keeper

Goals

- Fill in full week
- Complete as I go along
- Would like the voucher
- Do it as quickly as possible

Needs

- As much automation as possible
- No repetition
- Account transferrable between PC and phone and journeys brought across
- To stay motivated enough to complete a week of diary keeping

Expectations

- Quick to fill in
- Ability to pick 'favourite' journeys as my journeys in the week are much the same for five days
- No lag in performance and speed
- I expect it to take my location data and I have no problem with that

Pain points

- Long pages with lots of text
- Having to put the same thing in multiple times
- A lack of automation
- Having to self-moderate (e.g. no walks of under 1 mile after day 1)

Notes

Diary keeper would prefer the system to take as much data as needed from him - such as knowing where he is. Although he'd like the voucher his fatigue kicks in early with repeating the same journeys, so a repeat and return journey wizard would help him greatly.

He'd rather that he just gave the application all his journeys and the interviewer or someone else would discard the ones that don't qualify for the NTS, rather than him having to work out if a walk to the bus stop counts or not. Totally guesses the distances on public transport, and gives cursory information for ticket types/prices.

Diary Keeper



Amelie Lasalle

Age: 36

Temporary contract worker in a marketing firm. Lives with partner and two children.

Lives in a market town, shops close by but would rather drive to them than walk.

Regular commuter and visits family in county for childcare.

Digitally confident, obsessive user of smartphone, social media and applications. Apple devotee, phone gamer and avid TV consumer.

Roles

- Diary keeper for household

Goals

- Fill in diary easily
- Complete the diaries for household
- Get the voucher

Needs

- Optimised for phone/mobile
- Logical form flow
- Reminders and prompts
- Ability to edit mistakes

Expectations


- Don't want to repeat steps
- No complexity
- Won't have time to fill this in during the day so I expect to catch up later same day, or even next day... if I remember


Pain points

- Forgetting to fill it in
- Lack of automation
- Making mistakes and having to go back because of unclear instructions
- Stages, they're set up for public transport and I never use it
- Likewise the difference between journey arrival/departure times and time spent travelling. As a constant car driver the time travelling and the journey arr/dep are always going to match.

Notes

Diary keeper thinks of themselves as time poor, so is put off by anything they see as excessive admin. Reminders and prompts would help them, as would tailoring the onboarding instructions to be relevant to them.

<h2 style="text-align: center;">Diary Keeper</h2> <div style="text-align: center;">  </div> <h3 style="text-align: center;">Bridget Adams</h3> <p>Age: 45</p> <p>Divorced with 2 children who live with her part-time. Has anxiety.</p> <p>Lives in a small, rural town.</p> <p>Commutes by car for school run, to pick up children from other residence, to attend college and for social activities.</p> <p>Digitally confident, happy using phones, social media and applications. Has a smartphone and a Macbook laptop but primarily a phone user. Likely to fill in diary after the fact.</p> <p>Roles</p> <ul style="list-style-type: none"> ● Diary keeper for household 	<p>Goals</p> <ul style="list-style-type: none"> ● Fill in diary easily ● Complete the diary ● Record journeys later, probably in the evening <p>Needs</p> <ul style="list-style-type: none"> ● Optimised for phone/mobile ● Logical form flow ● Short processes ● Uncrowded pages ● Clear direction and routes through the process ● Motivation and encouragement <p>Expectations</p> <ul style="list-style-type: none"> ● No complexity ● Minimal barriers to getting onto the system ● Clean, uncluttered pages 	<p>Pain points</p> <ul style="list-style-type: none"> ● Too many steps ● Instructions that are too long ● Due to my anxiety, any barriers I encounter are likely to make me stop completely and abandon the diary rather than try and work out the issue <p>Notes</p> <p>The user testers associated with this persona both dropped out of the testing. This is likely to be due to the Covid-19 situation meaning onboarding was remote, and we were giving them test journeys to enter along with the instructions. It could have been that with the scenarios and the amount of text in the instructions it was too much to take in, combined with the background anxiety of the early stages of virus lockdown.</p> <p>Recommend moderated onboarding and testing at Beta with users who have anxiety, in particular to test page overload.</p>
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<h2 style="text-align: center;">Diary Keeper</h2> <div style="text-align: center;">  </div> <h3 style="text-align: center;">Daniel Mackenzie</h3> <p>Age: 38</p> <p>Visually impaired. Basic digital skills. Uses a screenreader.</p> <p>Lives with partner. Doesn't use public transport. Uses private transport and taxis.</p> <p>Basic digital skills. Uses laptop or iPad</p> <p>Roles</p> <ul style="list-style-type: none"> ● Diary keeper ● Likely to let partner keep diary for him if that's an option 	<p>Goals</p> <ul style="list-style-type: none"> ● Receive password and onboard smoothly ● Record journeys after the fact ● Complete diary <p>Needs</p> <ul style="list-style-type: none"> ● Auto-filling data wherever possible ● As few screens and fields per journey as possible ● Screenreader compatibility <p>Expectations</p> <ul style="list-style-type: none"> ● It will be more difficult for me than others ● Don't want to be repeating steps ● Will do this after the fact, once I'm settled at my computer ● I hope help will be available if I need it 	<p>Pain points</p> <ul style="list-style-type: none"> ● Too many fields per journey stage ● Knowing my journey distances ● Too much guidance text per page of fields <p>Notes</p> <p>There's no braille or large print version of the current paper diary available, so at the moment interviewers or another member of the household will fill in diaries on behalf of people who are unable to or who would struggle to fill them in.</p> <p>The digital diary would facilitate this, but also we have made an assumption that if the diary keeper uses a screenreader then it may be easier than filling in the paper diary. However, in Alpha, none of our user testers had declared visual impairment so these assumptions are untested.</p>
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Appendix 5: Previous NTS Studies

Digital Diary Discovery Report (2019) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/804635/nts-digital-diary-discovery-report.pdf

Modernising the National Travel Survey (2016) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641452/modernising-the-national-travel-survey.pdf

National Travel Survey 2011 GPS Pilot Field Report (2011) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230561/NTS_2011_GPS_Pilot_Field_Report.pdf

Processing of National Travel Survey GPS Pilot Data, a technical report (2011) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230562/Processing_of_NTS_GPS_Pilot_Data_a_technical_report.pdf

National Travel Survey 2011 GPS Pilot: summary analysis (2011) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230564/NTS_2011_GPS_pilot_a_summary_analysis.pdf

National Travel Survey GPS Feasibility Study Final Report (2009) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230570/NTS_GPS_Feasibility_Study_Final_Report.pdf

National Travel Survey GPS Feasibility Study Preliminary Phase (2008) -

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230569/NTS_GPS_Feasibility_Study_Preliminary_phase.pdf

Appendix 6: National Travel Survey trials and reports from other countries

The Swiss Mobility and Transport Microcensus - http://www.strc.ch/2017/Danalet_Mathys.pdf

The TABI Travel app: Feasibility of data collection via a smartphone app - [https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20\(Southampton\).pdf](https://www.ncrm.ac.uk/research/datacollection/Lugtig%20et%20al%20-%20TABI%20app%20(Southampton).pdf)

Smartphone Based Travel Diary Collection: Experiences from a Field Trial in Stockholm, paper presented at the European Transport Conference 2016
https://www.researchgate.net/publication/309135632_Smartphone_based_travel_diary_collection_Experiences_from_a_field_trial_in_Stockholm

Future Mobility Survey: Experience in Developing a Smartphone-Based Travel Survey in Singapore
http://web.mit.edu/czegras/www/TRB_FMS_Overview_Final.pdf

Automatic trip and mode detection with MoveSmarter: first results from the Dutch Mobile Mobility Panel
<https://www.sciencedirect.com/science/article/pii/S2352146515003130>

Lessons learned from the New Zealand Household Travel Survey – 7 day online GPS
<https://www.transport.govt.nz/assets/Uploads/Research/Documents/2018-Transport-Knowledge-Presentations/c0c9896fdf/Lessons-learned-from-the-New-Zealand-Household-Travel-Survey-7-day-online-GPS.pdf>

Appendix 7: GDS Assessment

National Travel Survey

Assessment date: 22nd April 2020
Stage: ALPHA
Result: Met
Service provider: DfT

Assessment panel:

Personal information on assessors will not be published

Service description

National Travel Survey is a questionnaire and one-week travel diary, completed annually by 15,000 random participants using pen and paper. This has been running for over 50 years.

A Discovery phase carried out in 2018-19 concluded that a well-designed digital diary would better meet user needs than a paper diary as it could collect better quality data and reduce respondent burden.

1. Understand users and their needs

Decision

The service has met point 1 of the Standard .

What the team has done well

This is a time-consuming survey system, which has proven delays in obtaining statistics. Data is usually 6 months out of date by the time the information has been captured and coded by third party, and received at DfT for analysis.

The current system proves difficult due to the complexity of information needed from respondents; one key issue is the rules around the information that have been in place since the survey was introduced 50 years ago.

The team have conducted user research looking at transitioning the survey online. They have undertaken a range of research with different user groups (Interviewers, coders and end-users), and have used a number of different methods; In-depth contextual interviews and remote sessions via telephone and e-mail. It was good to see that geography had been considered as part of the recruitment, and the team should build on this to ensure insights are as representative as possible.

The team have observed a number of users whilst using the new survey, and have received detailed feedback to support improvements and developments.

They found some barriers around the framing of the survey given its complexity, and the need for timely completion.

The team have created a good set of representative personas around the service.

About assisted digital, the team have considered assisted digital and accessibility, and have tested with a small number of users with specific needs around cognition due to ASD, Dyslexia and Stress & Anxiety disorder. The team are looking to work with Digital Assisted Centre (DAC) to aid their research.

There is a plan in place for beta, where the team will be looking at what testing has been successful, what is working well, not working so well.

What the team needs to explore

I would recommend in the beta stage that research be carried out with users who have broader accessibility needs, and that the team link their personas to the Digital Inclusion Scale specifically.

At present the research has been focussed on the 'As-is' state. The team should include end-state outcomes in their research wherever possible – for example begin to understand core user needs around a digital service, where there is no face-to-face interaction with an interviewer. How that would change the user need in terms of content and assisted digital support?

In order to achieve a digital service, the team need to look at simplification in every part of the Survey. To make the user journey less complicated and to allow DfT to get better quality data more quickly, the rules underpinning the survey need to be reviewed. Every opportunity should be taken to improve the user experience.

The Road Freight Survey team in DfT also have an ambition to digitise an existing paper survey, and whilst the user base and data being recorded are very different, there could be some common ground in terms of how challenges are identified and addressed.

2. Solve a whole problem for users

The team appear to have good understanding of the wider service context and the interactions across all user groups. The team have clearly worked with a broad range of users and feedback provided from a range of research methods.

Decision

The service met point 2 of the Standard.

What the team has done well

The panel was impressed that:

- The team have a good understanding of the context in which the service sits
- Identified what they need to consider as part of their public Beta Development

What the team needs to explore

Before their next assessment, the team needs to:

- Clearly demonstrate how all elements of the user journey come together to create one service.
- Demonstrate how they have used data to support and improve the user journey

3. Provide a joined-up experience across all channels

The team are focused on providing a digital service. The existing solution would be available for current users and the aim is to migrate them to the new solution.

Decision

The service met point 3 of the Standard.

What the team has done well

The panel was impressed that:

- User journeys for “to be” service are clearly defined
- Clearly identified the needs of a digital service and tested this with users, iterating based on feedback
- Consideration has been given to an assisted digital solution and how that could be implemented

What the team needs to explore

Before their next assessment, the team needs to:

- Provide robust data on channel usage across the service along with customer satisfaction information
- Evidence how the assisted digital option works.
- Test the service with accessible users and iterate from this feedback

4. Make the service simple to use

Decision

The service has met point 4 of the Standard.

What the team has done well

The team have prototyped and tested the key user journeys
The team have iterated the user journey flow and content based on insight and feedback
The team have explored different solutions, such as an app

What the team needs to explore

Before their next assessment, the team needs to:

- Design and test the end to end user journey
- The team have mentioned that on-boarding guidance is proving challenging for some users. Every effort should be made to replicate the end to end journey, with all participants acting out their roles
- Resolve discrepancies in current capture rules and user expectations
- The survey has historic rules around walking or waiting times which users have mentioned is confusing
- Users can't currently record a roundtrip - like walking the dog
- Ensure the service works with a range of devices and at a range of screen sizes

5. Make sure everyone can use the service

Decision

The service has met point 5 of the Standard.

What the team has done well

Recruited and tested with users with access needs

The designs shown are mostly consistent with the GOVUK Design System

What the team needs to explore

Before their next assessment, the team needs to:

- Conduct usability testing with low ability users (Digital Inclusion Scale 0-3) to validate the design and content decisions

- Continue to recruit and test with users with permanent and contextual access needs

- Continue best efforts to recruit and test with users with access needs

- Demonstrate a detailed plan of the assisted digital support model including:

 - How it will be delivered

 - How it has been tested throughout private beta

 - Make use of the accessibility profiles on GOVUK to avoid common access barriers and conduct empathy walkthroughs or any designs:

 - (<https://www.gov.uk/government/publications/understanding-disabilities-and-impairments-user-profiles>)

 - Conduct an accessibility audit and create an accessibility statement

6. Have a multidisciplinary team

Decision

The service met point 6 of the Standard.

What the team has done well

The panel was impressed that:

- There was continuity of team members across the core disciplines required and there is a clear plan for key roles in the next phase

- The team are using a number of collaboration tools

What the team needs to explore

Before their next assessment, the team needs to:

- Ensure that if any team members change that a full knowledge transfer is undertaken

7. Use agile ways of working

Decision

The service met point 7 of the Standard.

What the team has done well

The panel was impressed that:

- Agile Ceremonies were being undertaken on a regular basis

- The team has engaged well with other areas across the business and incorporated their feedback in to the service development

8. Iterate and improve frequently

Decision

The service met point 8 of the Standard.

What the team has done well

The panel was impressed that:

The team provided a detailed account of what tools and techniques will be used to identify service improvements in Beta

What the team needs to explore

Before their next assessment, the team needs to:

Demonstrate how service improvements are prioritised

Clearly articulate how the service will be deployed to users

9. Create a secure service which protects users' privacy

Decision

The service met point 9 of the Standard.

The scope of the Alpha phase to provide a web based front-end service for users to upload their travel data. A secure API connection to provide the data for NatCen (DfT 3rd party) and research the use of a native app for users to track their journeys via GPS.

In addition, the team have researched the use of a 'companion app' for users to collate their travel information via GPS to improve the accuracy of the data.

The team have built an application, which is hosted on DfT GPS platform and based on a docker architecture. The application uses a PostgreSQL database to store data. The application uses the PHP and Symfony framework for the front end, which is open source, which is hosted within the Google App Engine.

Solution design has been given the approval from DfT Architecture Change Board. With the exception of user email addresses, which are stored within the logs, no personal data is stored within the application.

Firebase is used to handle authentication in line with DfT principles and Standards. There is no access to the diary data and this is deleted following the transmit to NatCen DPIA complete for the Web app.

In terms of threat vectors, the service has scored as very low. The most significant threat is of an insider acting with malicious intent, but as there is no personal data and the users are unidentifiable in the service, this would be highly unlikely to occur.

The ability to prevent against DDoS attacks the service will be assessed in the next stage. Security Unit tests have been undertaken Vulnerability and penetration testing will be at the next stage.

More investigation is required for the 'Companion App'

What the team has done well

The panel was impressed that:

The team had clearly identified the need to secure data at rest with encryption

What the team needs to explore

Before their next assessment, the team needs to:

Assess the security requirement for the Companion app
Undertake the appropriate vulnerability and penetration testing at the next stage

10. Define what success looks like and publish performance data

Decision

The service met point 10 of the Standard

What the team has done well

The panel was impressed that:

The team has identified a set of KPIs and indicated how these will be measured

11. Choose the right tools and technology

Decision

The service did meet point 11 of the Standard.

DfT has defined their platform service are provided on the GPS and the team have utilised the services required from GPS. The service is scalable to allow an increase of users

The system stores data in Postgres which is an SQL database and makes use of REST api's to allow NatCen to access the data. All data is encrypted at Rest. Connections between the two is via SSL.

Web front tools were based on experience and knowledge of the team and are open sourced. The testing is fully automated, with the team having built an automated CI/CD pipeline. Although no performance and load testing has been carried out, given the nature of the cloud based containerized solution, the system is anticipated to be more than capable of being able to manage the expected number or hits per day, somewhere in the hundreds of users. No performance testing has been undertaken but is planned for future stages.

For the 'Companion app' the team have used React Native and the Expo application which are open sourced, the data is hosted on GPS using SQL lite. All technologies are acceptable for use with both IOS and Android devices. The team have ensured that the tools have compatible libraries and can be used regardless of the application.

To date only internal testing has been run but have plans for wider testing during the next phase.

What the team has done well

The panel was impressed that:

The team appeared to have a clear understanding of the landscape and explored the available solutions

The team have applied Industry standard tools with cloud first approach

Understood the cost of ownership of the technology choices and applied an effective approach

What the team needs to explore

Before their next assessment, the team needs to:

The team need to continue development of the web-based digital diary

Complexity in terms of technical considerations, business decisions and data management need further investigation for the Companion App prototype

12. Make new source code open

Decision

The service did meet point 12 of the Standard.

All source code has been open sourced by uploading it to the DfT GitHub repo. Users can clone the repo and develop extensions on top of the existing code. Even though the service is being developed by contract resource, they have confirmed DfT owns all of the intellectual property rights.

Should the service be offline, users who have ingested the previous days data will still be able to continue to use that. Should GPS be unavailable for any period of time, due to the architecture employed in this solution it would be relatively straightforward to deploy the service to another cloud provider.

What the team has done well

The panel was impressed that:

- All code has been privately open sourced by uploading to the Git Hub
- Users can clone the repo and develop on top of the existing code.

What the team needs to explore

Before their next assessment, the team needs to:

- all code has been publicly open sourced by uploading it to the Git Hub

13. Use and contribute to common standards, components and patterns

Decision

The service met point 13 of the Standard.

What the team needs to explore

Before their next assessment, the team needs to:

- Share details of any components or patterns they create or adapt (for example, by contributing to the GOV.UK Design System)
- Time input
- Currency input

14. Operate a reliable service

Decision

The service did meet point 14 of the Standard.

What the team needs to explore

Before their next assessment, the team needs to:

- Demonstrate how users would be able to complete their journey should the service go offline

Next Steps

This service needs to address the recommendations in the report before their next assessment [at Beta].